# REPORT RESUMES

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REORGANIZED SCIENCE CURRICULUM, 10A, BIOLOGY SUPPLEMENT.
MINNEAPOLIS SPECIAL SCHOOL DISTRICT NO. 1, MINN.

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THE SIXTEENTH IN A SERIES OF 17 VOLUMES, THIS VOLUME PROVIDES THE BIOLOGY TEACHER WITH A GUIDE TO THE REORGANIZED SCIENCE CURRICULUM OF THE MINNEAPOLIS PUBLIC SCHOOLS. THE MATERIALS ARE INTENDED TO BE AUGMENTED AND REVISED AS THE NEED ARISES. VOLUME 10A CONTAINS THE INTRODUCTORY MATERIAL, AND THE SECTIONS (1) CONCEPTS, (2) REFERENCES, (3) LOOKING FOR AN IDEA, AND (4) IMPROVING INSTRUCTION. VOLUME 10B CONTAINS RELATED SECTIONS ON (1) FILMS, (2) FILMSTRIPS, (3) EQUIPMENT, AND (4) ORDERING AND REPAIRING. (DH)

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## SCIENTIFIC APPROACH TO PROBLEM SOLVING

1. Observation--first-hand experiences and observation.
2. Definition of PROBLEM--ask questions, choose one for investigation.
3. Results of other investigators--read about problem, discuss it with interested friends and resource people, examine the written material.
4. Possible solutions--list all possible guesses.
5. Choosing the best solution (HYPOTHESIS)--pick the "best guess".
6. Testing the hypothesis--planning and carrying out EXPERIMENTS to determine its truth.
7. CONCLUSION of accepting or rejecting hypothesis--draw conclusion from experiments to determine acceptance or rejection of "best guess".
8. More extensive testing of hypothesis--experiment further to determine if hypothesis always holds true.
9. Stating the THEORY and publishing results--restate the hypothesis in light of the above experimentation, publish in professional journal.
10. Finding mathematical proof--do any measuring and mathematical calculations to develop proof of theory.
11. Statement of LAW or PRINCIPLE--if no one can find a mistake in the mathematical proof or develop a contrary proof, the theory becomes a law or principle.

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# THE BIOLOGY SUPPLEMENT

to the

# REORGANIZED SCIENCE CURRICULUM

Kindergarten Through Grade Twelve

(For Discussion Purposes Only)

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# FOREWORD

Long before that famous October fourth, 1957, when Sputnik I rocketed into orbit, the science teachers of the Minneapolis Public Schools eagerly began work on the reorganization of the science curriculum from kindergarten through grade twelve. This reorganized science curriculum was requested by our instructional staff and developed by representative members of that staff.

The citizen of today must be science literate in order to exercise adequately his duties of citizenship. The contribution of the scientist to our way of life is the methods which he uses to attack a problem and seek its solution. These methods are unique, but more important, they are very useful; they can be applied in the solution of the everyday problem by knowledgeable children at all ages and grade levels, and by adults in all walks of life. If these methods of science are to be learned by the youth of Minneapolis, they must be learned by attacking realistic problems inside and outside the classroom. This practice in the solving of work-a-day problems trains our young citizens to think for themselves in seeking new solutions to age-old problems of our civilization.

In the Minneapolis Public Schools we recognize that science is a very important part of the liberal arts general education which should be studied by all students. We are aware of our responsibility for instruction which must be well grounded in the fundamental laws and principles in all the fields of the basic sciences and therefore propose this reorganized curriculum for teaching the ever-expanding knowledge of science.

This reorganized science curriculum does not teach itself. It is a planned developmental approach in which the teacher is the expeditor and not the limiter of learning. The curriculum has been developed to aid the student in acquiring new breadths and new depths of understanding of his environment; and with it a teacher who is well trained in science may lead the student in an ever-expanding investigation of his surroundings in this world and universe. If the curriculum is used cooperatively by teacher and students, it is an instrument which can mold a pupil of the Minneapolis Public Schools into a science-literate citizen who, if he continues advanced science training, may become a scientist of the future.

Rufus A. Putnam
Superintendent of Schools

# INTRODUCTION

This Supplement has been prepared as a convenient reference to assist the biology teacher in his task. Biology teachers suggested and assisted with the preparation of each section of this Supplement. The value of it can only be determined by use during the teaching of biology. If you have suggestions for the improvement of this Supplement, please contact the Science Department Office.

This Supplement is not complete at the present time. When additional materials are available, a copy will be furnished to you to place in this loose-leaf binder. Your cooperation with us to keep you Supplement up to date will be appreciated. When you leave your school, please leave the Supplement for the next biology teacher to use.

# INTRODUCTION TO CONCEPTS

The concepts (mental understandings) to be taught in a year of biology are listed under the major topics of the Reorganized Science Curriculum. Major topics and the accompanying concepts may be expanded or contracted but should not be ommitted from any one year course in biology. The understandings listed under the Introduction to Science, including attitudes, tools and methods, should be included throughout the year's work. They are all a part of "Sciencing."

These concepts are not to be memorized, but must be taught in such a way that each pupil has an understanding of its meaning. The emphasis a teacher places on each major topic will depend upon the levels of the pupils being taught.

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Grade 10

# ALLOCATION OF CONCEPTS BY MAJOR TOPICS

Note: This report presents a list of major topics, within which the order of concepts found in the Handbook in most cases has been changed to provide a logical teaching approach.

## Introduction to Science

### A. Attitudes (including history)

1. Only a few of the problems which will be solved in the future are recognized now.
2. Basic research contributes to economic and social progress.
3. Consumer demand for products accelerates research.
4. Many people of varying levels of skills and abilities contribute to the development of a new product.
5. Cooperation between scientists and technicians increases productivity.
6. Creative and imaginative thinking is a part of creative scientific work.
7. By applying the principles of basic research, man continually strives to raise the standard of living (the ability to do productive work with less physical effort and to have a greater amount of leisure time).
8. Many scientific theories about cause and effect relationships were developed from extended experimentation followed by abstract reasoning by recent scientists.
9. Creative scientific work usually progresses most rapidly when the problems are interesting to the investigator.
10. Awareness of surroundings, perception of environment, and analysis of occurrences are attributes of the scientist.
11. Intellectually honest scientists have a regard for the integrity of others, a critical attitude toward their own investigations, a willingness to test and retest all data and conclusions, and the patience and persistence to analyze all obtainable facts before conclusions are drawn.

A. Attitudes (including history)

12. A scientist must use a great amount of self-discipline to achieve the following mental habits: recording of all accurate observations, applying a critical attitude toward his own research and the research of others, withholding of judgment on cause and effect relationships until all experimental information is collected and evaluated, and planning of all experimentation with one and only one variable.

13. Apparent disorder when studied sufficiently takes on order if there is an appropriate point of reference.

14. Regardless of the method of analysis, order can not be found and conclusions can not be drawn from insufficient data.

15. In organizing a group of observations or data, the conclusions drawn may depend upon the point of view from which the observations are being analyzed.

16. Information about scientific investigations should be disseminated in order to promote continual progress.

B. Tools

1. Greater precision of measurement results in more accurate constants and equivalents.
2. In order to thoroughly understand a scientific treatise one must study the vocabulary of that specific area of science.
3. Many widely diversified publications review the results of scientific investigations.
4. Scientists may use all forms of mathematics in computation.
5. The refinement of instruments for measurement enables the scientist to collect more accurate data and correct former errors.
6. Measurement of matter enables us to describe some properties of substances consistently, accurately, and specifically.
7. Development of more accurate measurement may be considered the impetus moving physical scientists from qualitative to quantitative descriptions.
8. Dimensional analysis may be considered a tool for gaining knowledge and recognizing relationship in physical science.
9. Various types of mathematical notation may aid in analysis of property measurement (scientific notation, approximation, order of magnitude).
10. Measurement analysis can result in no finer accuracy than the measuring instrument used to make the measurement.
11. Improper use of mathematical processes may result in false accuracy in measurement analysis.
12. An inverse relationship exists between units and numbers in measurement systems--the smaller the units used, the larger the number.
13. Several methods may be available for measurement of a characteristic, but all results may not be compatible unless a particular method is stated.
14. Certain measurements may incur errors unique to that type of measurement.
15. Fundamental magnitudes may be considered those quantities measured directly in terms of defined units.
16. Quantities that possess only magnitude are scalar quantities; e.g., area volume, work, power.

B. Tools

17. Quantities that have both direction and magnitude are called vector quantities.

18. Quantities which have direction and magnitude can be added or subtracted geometrically to find a resultant quantity.

19. In experimental "reporting", it may be convenient and useful to elucidate the variation within the experiment by mathematical notation (±%).

20. Reference to experimental deviation from "known" accepted value is sometimes made in terms of ratios (per cent of error).

### C. Methods

Scientific hypotheses are repeatedly tested before they are considered correct.

## II. Living Things

### A. Life and life processes

Life in general

1. All living things are made of protoplasm.
2. Every living cell consists essentially of a mass of protoplasm which is usually differentiated into a central (regulatory) portion, the nucleus, and an outer portion (cytoplasm) which is surrounded by a cell membrane.
3. The nucleolus is a small structure usually found in the nucleus of a cell.
4. Living things are made only from some of the lighter chemical elements.
5. An organism, whether one-celled or many-celled, is an individual living thing and can carry on the fundamental processes.
6. All the systems working together form the total organism.
7. All living organisms (except viruses) carry on the fundamental processes; food taking or nutrition, digestion, absorption, circulation, respiration, assimilation, oxidation, excretion, reproduction, growth, and responsiveness.
8. In bacterial spores the life processes are usually at a minimum.
9. During their life cycle animals which metamorphose may change the method by which they carry on some of their life processes.
10. All physical and chemical processes concerned with the activity, maintenance, and growth of an organism are included in the process of metabolism.
11. Metabolism involves both constructive and destructive processes (anabolism and catabolism).
12. Energy and matter are not created or destroyed in the reactions associated with the life processes; some are passed on from organism to a succeeding organism in endless succession.
13. Part of the solid material in living cells may be mineral.
14. Some minerals are dissolved in the liquid in cells.
15. The optimum water content of all living organisms is not the same.

Life in general (continued)

16. All chemical reactions in living organisms require energy to start them.

17. Some chemical reactions in living organisms are endothermic and some are exothermic.

18. Chemical compounds are often changed during fundamental processes.

19. Certain chemical compounds needed by specific cells must be produced within the same cells.

20. Some chemical compounds needed by specific cells may be produced in other types of cells within the organism.

21. The endocrine system produces certain regulatory materials which may act in other parts of the vertebrate animal.

22. Active animals require an occasional period of rest which allows their bodies to reestablish chemical equilibrium.

23. Inactivity of a muscle weakens it by decreasing the muscle-cell's capacity for food intake and excretion of waste materials.

A. Life and life processes

Food taking or nutrition

1. An organism must take in all the chemical elements used in the life processes.
2. In order for protoplasm to be produced, the organism must take or make the materials which constitute protoplasm.
3. Some organisms cannot make all the materials which are necessary for survival.
4. Animals must depend upon plant foods for the source of carbon compounds essential for their lives.
5. Parasites and saprophytes secure their food from living and dead plant and animal materials.
6. Certain controlled amounts of organic nutrients, minerals, vitamins and water are necessary to sustain life.
7. Some chemical compounds necessary to living cells may be secured from foods taken into the organism.
8. The organic nutrients necessary for healthful living are carbohydrates, fats and proteins.
9. Some chemical elements are necessary in very small amounts in order to promote normal growth and development of living things.
10. Some nitrogen compounds necessary for living things may be obtained as nitrates from soil or the air.
11. Only certain kinds of plants can take nitrogen from the air and use it in their protoplasmic structure.
12. If a diet does not contain a sufficient amount of organic nutrients, vitamins, minerals and water, deficiency diseases may develop.
13. Although the amounts of organic nutrients, vitamins and minerals taken into the body may be adequate, specific amino acids, fatty acids, vitamins and minerals may be lacking.

## A. Life and life processes

### Digestion

1. Foods are changed to simpler forms before they are absorbed into the body.
2. The digestive system simplifies foods and makes them available to the organism.
3. Usually during the process of digestion, complex proteins become amino acids, fats become fatty acids, and carbohydrates become simple sugars.
4. All materials in the alimentary canal are not a part of the organism.
5. Most food is digested in the small intestine in vertebrate animals.
6. Each living thing cannot digest all the kinds of food materials.

## A. Life and life processes

### Absorption

1. Living things take organic nutrients, minerals, vitamins and water into the body fluids.
2. The movement of fluids which contain nutrients and/or metabolic wastes, through living cell membranes requires energy.
3. Energy in the form of osmotic pressure is necessary to move water in and/or out of living cells through the cell membrane.
4. Living things take organic nutrients, minerals, vitamins and water into the cell fluids.
5. The balance of fluids necessary for life in an organism is controlled by each living cell.
6. The membranes of root hairs are selective for the dissolved minerals to be passed into the plant.
7. The absorption of water and dissolved minerals into a plant is an active, selective and energy-consuming process.
8. If the concentration of dissolved minerals in the soil water is too great, the direction of osmosis will be reversed and the plant may die.
9. Digested carbohydrates and proteins are absorbed directly into the bloodstream through the villi of the small intestine.
10. Digested fats are absorbed through lacteals into the lymphatic system.

## A. Life and life processes

### Circulation (including secretion)

1. Most cells of a complex organism are in contact with the liquids or the circulatory system.
2. In the spring in the temperate zone some of the foods stored within the plant are translocated to supply the energy for increased life activity.
3. Some of the forces causing the sap to move upward in a tree are the combined energy of osmosis, transpiration and capillary action.
4. The xylem and phloem columns and layers of cells in roots, stems and leaves are the conducting structures of the plant's transportation system.
5. The circulatory system within an animal moves the necessary body fluids throughout the entire organism including its many parts.
6. In mammals, the heart is constructed as two parallel pumps, the right side responsible for circulation to the lungs and the left side for circulation to all other parts of the body.
7. The blood pressure of an animal is usually controlled by the size of the capillaries.
8. In some warm-blooded animals blood vessels may expand or contract in a specific area to aid temperature control.
9. In higher animals the fluid part of the circulatory system is made up of two parts, the blood usually in a closed system and lymph in a partially closed system.
10. Some intercellular fluids which surround most living cells do not return directly to the bloodstream but are collected in lymphatic vessels.
11. Digested fats enter the bloodstream by way of the lymphatic system.
12. Lymph carries digested fats and wastes in liquid form from intercellular spaces and empties them into the bloodstream at the subclavian veins.
13. The lymph is moved in the lymphatic system by means of muscular action.
14. Muscular activity of the organism aids in the return of blood and lymph to the heart.

Circulation (continued)

15. Certain chemical compounds needed in intercellular spaces may be produced within the organism or may be taken into the organism.

16. Many glands or tissues produce chemical compounds which are collected into ducts.

17. Exocrine (ducted) glands usually have a more localized effect than endocrine glands.

18. Some chemical compounds made by cellular activity may be secreted into ducts which carry them to the parts of the organism where they are needed.

19. Endocrine (ductless) gland secretions have a widespread influence on the organism since the secretions go directly into the bloodstream.

A. Life and life processes

Respiration

1. Oxygen for life is secured through different structures in different kinds of organisms.

2. In an environment, the concentrations of oxygen and carbon dioxide have much to do with the regulation of respiration.

3. All tissues respire and in higher organisms a circulatory system is needed to deliver oxygen to the tissues and remove carbon dioxide from them.

A. Life and life processes

Assimilation

1. In order for living material to be synthesized, the organism must take in or make the materials which constitute the living material.
2. When organic nutrients, minerals, vitamins and water are inside the cell, they may become a part of the living material, may be oxidized, or may be stored.
3. Assimilation (anabolism) involves all the chemical processes necessary to change basic simple nutritives into living materials.

A. Life and life processes

Oxidation

1. Oxidation of organic nutrients is a complex process involving many chemical reactions.

2. Oxidation of organic nutrients occurs only within the living cells.

3. Oxygen absorbed into the body from the lungs is the oxidizing agent which converts food into heat and mechanical energy.

4. Catabolism is the tearing down of living cells and/or the release of energy from organic nutrients.

5. Chemical changes accompany fatigue.

6. Some energy available from digested and absorbed foods is used to supply the energy required for digestion and absorption.

7. Chemical imbalance in an organism resulting from disease may cause rapid oxidation, which may elevate the temperature.

A. Life and life processes

Excretion

1. The elimination of waste products and the maintenance of metabolic equilibrium in an organism is usually called excretion.

2. Metabolic activities result in wastes being formed.

3. Wastes from cellular activity are excreted into spaces adjoining the cells.

4. Accumulated waste products are usually toxic and therefore detrimental to an organism.

5. The waste products of all organisms must be isolated and/or removed from the organism to prevent self-poisoning.

6. Waste products of a plant, other than carbon dioxide and oxygen, are deposited in different parts of the plant, instead of being eliminated immediately from the plant.

7. Plants have few, if any, specialized structures for the elimination of liquid and solid metabolic wastes.

8. Since the metabolic rate of normal animals is greater than that of plants, there is a greater volume of wastes to be excreted.

9. Excretory systems are made up of specialized organs and structures.

10. The liver converts worn out hemoglobin, excess amino acids and other wastes of metabolism into urea which may be eliminated by the kidneys.

11. Kidneys are dynamic selective filters, which remove most converted metabolic wastes from the blood.

12. Undigested foods, indigestable foods and some products of catabolism pass from the alimentary tract as feces.

A. Life and life processes

Reproduction and growth

1. The length of life of all organisms varies between species and among members of a specific species.

2. Growth is the result of some physical and chemical changes in living things.

3. Growth and maturation is usually accomplished by the increase in the number of living cells in an organism by a complicated process (mitosis).

4. The replacement of injured or worn-out cells is accomplished by a complicated process of cell reproduction (mitosis).

5. In mitotic cell division, the chromatin and other materials are distributed in such a way that the resulting two cells are identical.

6. The nucleolus usually disappears during cell division.

7. Most cells reproduce by the division of the parent cell into two daughter cells.

8. Root systems of some plants may be split for propagation purposes.

9. In the lower plants reproductive structures usually develop spores.

10. Asexual reproduction is uniparental.

11. In asexual reproduction fusion of two nuclei does not precede division.

12. Some youthful characteristics are acquired by a few simple plants and animals through the process of exchanging protoplasmic constituents of cells (conjugation).

13. The reproductive cycle of some plants includes successively sexual and asexual stages (alternation of generations).

14. The life cycle of the mosses, ferns and related plants includes a sexual (gametophyte) and an asexual (sporophyte) phase.

15. Many protozoans multiply by transverse cell division.

16. Characteristics of parents are usually passed to their offspring through the genes (DNA molecule) on the chromosomes in the reproductive cells.

Reproduction and growth (continued)

17. During the formation of an ovum (meiosis) in plants and animals, cell division does not always result in equal-sized daughter cells.

18. During meiosis, the chance distribution of genes on specific chromosomes results in a large number of possible heriditary combinations.

19. The sex of the offspring of higher animals is determined by the chromosome content of the sperm which fertilizes the egg.

20. In some species of worms and insects, apparently fertilization is not a necessary part of reproduction.

21. Eggs of some animals have developed into new individuals as a result of adequate stimulation without the addition of sperm.

22. The early embryo of most animals appears the same until differentiation begins.

23. The embryos of mammals have great resemblance.

24. The modern study of heredity is based on the results of Mendel's experimentation with the inheritance factors in garden peas.

25. Heriditary characteristics are considered to be dominant-recessive, or blended (mosaic).

26. A characteristic which is of a dominant-recessive type will be found as dominant in the offspring if both dominant and recessive genes are present.

27. A characteristic which is of blend or mosaic type will be found as a blend in the offspring if both genes are present.

28. Selective breeding, a method of making living things more useful to man, has a scientific basis

29. Some varieties of domesticated plants and animals are crossbred to develop more desirable characteristics in hybrids.

30. Hybrid animals or plants are usually produced by crossing one animal or plant with another animal or plant of the same variety.

31. By cross-breeding of closely related varieties of species, desirable hybrids are occasionally developed.

32. Occasionally a new hybrid is produced by multiple crosses of parent varieties having the desired traits.

Reproduction and growth (continued)

33. Some living things do not reproduce (mule).

34. Some living things do not breed true (apples, plums).

35. Diseases of plants and animals usually decrease productivity and virility.

36. Most organisms produce like organisms except in the case of a mutation, or "sports".

37. Sometimes organisms produce offspring known as anomalies or mutants which are dissimilar to the parents.

38. Sometimes organisms do not breed true and produce mutants with traits which are transmitted to their offspring.

39. Mutants or "sports" are the result of sudden changes in inherited characteristics.

40. Rarely are any mutants of a species worthy of perpetuation.

41. Living things may be altered through evolution.

42. The gradual modification of successive generations of living things is evidence of evolution.

43. Fossils furnish most of the evidence regarding the evolution of living things.

44. Fossil evidence furnishes information which indicates that certain unlike animals may have a common ancestry.

## A. Life and life processes

### Responsiveness

1. All living things are slowly changing in response to their changing physical environment.
2. Many living things may change their position or the position of their parts when they come in physical contact with other objects.
3. Many organisms are sensitive to pressure changes.
4. Some living things are very sensitive to rapid changes in temperature and pressure.
5. Many living things will orient themselves or their parts to the force of gravity.
6. Many living things are sensitive to light and will move to secure an optimum amount of light.
7. The ground roots of most plants grow away from light, toward the center of the earth and toward the source of water.
8. Organisms are sensitive to the amount of moisture in their environment.
9. Information regarding our environment is usually gained through our five sense organs (sensory nerves).
10. Odors, colors and sounds are forces which may stimulate responses in organisms.
11. Hearing is the detection of sound.
12. Many organisms are sensitive to electrical currents.
13. A chemical may be the stimulus to which an organism may respond.
14. Some insects are able to sting some plants in such a way as to cause the plant to produce an abnormal growth or gall.
15. An organism is sensitive to many internal stimuli.
16. Nerve impulses which originate in the spinal cord or brain are transmitted by motor nerves.
17. Nerve impulses are elecrical pulsations transmitted by a neuron.
18. Exercise stimulates responses from respiratory, circulatory, excretory and nervous systems of the body.

Responsiveness (continued)

19. Extreme fatigue is very often nervous exhaustion rather than physical exhaustion.

20. Reflexes, described as simple, unlearned and automatic acts, may be favorably modified through training.

21. Habit, a learned act or combination of learned acts which has its foundation in the nervous system, tends to become automatic with practice.

22. Instincts, which are inherited complex forms of behavior, may serve as a basis for the development of desirable habits.

## II. Living Things

### B. Classification

1. The artificial classification of plants and animals has been arranged into keys for the identification of organisms by taxonomic names and groups.

2. One-celled organisms have various ways of moving.

3. Only a few living things can produce light.

4. Some bacteria can produce light.

5. Only certain kinds of plants can take nitrogen from the air and use it in their structure.

6. Plants which do not produce embryo plants may be classed as green or non-green plants.

7. Plants may be grouped according to production or non-production of embryo plants.

8. Plants may be grouped into those which have true roots, stems, leaves, and flowers and are seed-producing; and those which are not seed-bearing.

9. Plants with transportation systems may be grouped together according to their seed-producing or non-seed producing ability.

10. Plants which produce embryo plants may be classed as vascular or non-vascular.

11. Viruses, bacteria, fungi, rickettsias and protozoa have many similar characteristics but differ in size.

12. Fungi are non-green thallophytes which develop as branching, threadlike plant structures.

13. Most contagious diseases of plants and animals are caused by pathogens which are fungi.

14. Algae, fungi, liverworts and mosses do not possess true roots, stems, leaves or flowers.

15. The life cycle of the mosses, ferns and related plants include a sexual (gametophyte) and an asexual (sporophyte) phase.

16. The number of aquatic organisms exceeds that of terrestrial organisms.

B. Classification (continued)

17. Seed-bearing plants may produce seed in a dried case or encased in a ripened ovary.

18. Seed plants are very often classified into two groups: cone-producing plants with naked seeds and flowering plants with true seeds.

19. Conifers or cone-bearing trees produce naked seeds from incomplete flowers.

20. Plants with "woody" stems usually have two seed leaves while plants with "pithy" stems usually have only one seed leaf.

21. Flowering plants (Angiosperms) may be grouped according to the number of seed leaves.

22. A few flowering plants produce non-viable seeds.

23. Fruits are classified as either fleshy fruits or dry fruits according to the structure of the mature ovary.

24. Specific organs and systems develop from the cell layers designated in early embryological development as ectoderm, endoderm and mesoderm.

25. There are various types of muscles, each of which is especially adapted to certain activities.

26. Single-celled animals or single-celled animals living in colonies are usually classified as Protozoa.

27. Animals which are composed of many interdependent cells with many body pores and a skeleton made up of spicules, and which have no organs or movable parts are usually classified as Porifera or sponges.

28. Multicellular animals whose bodies have only two layers of cells, have no head or segmentation, are radically symmetrical and usually have tentacles with stinging cells are classified as Coelenterata.

29. During their life cycle animals which have metamorphosis may change the method by which they carry on some of their life processes.

30. Complex multicellular animals whose elongated, cylindrical, worm-like bodies have three germ layers, a complete digestive tract with mouth and anus, but no circulatory system or appendages are classified as roundworms or Nemathelminthes.

B. Classification (continued)

31. Complex multicellular, three-germ-layered, segmented worms which have a closed circulatory system and no skeleton are called annelids or Annulata.

32. Complex multicellular, three-germ-layered, soft-bodied animals whose bodies are unsegmented and covered by a dorsal mantle that usually secretes a calcareous shell are classified as mollusks or Mollusca.

33. Complex multicellular animals whose bodies have three germ layers, a simple digestive system, a skeleton of spiny plates, tube feet, and which, in the adult stage, are usually radically symmetrical are classified as Echinodermata.

34. Complex multicellular, three-germ-layered animals with external skeletons, segmented appendages, and whose life cycles demonstrate the stages of complete or incomplete metamorphosis are classified as Arthropoda.

35. In the detailed classification of insects structures on the head, thorax and abdomen are used for identification.

36. Many insects are classified into the various orders upon the basis of wing structure.

37. Complex multicellular, three-germ-layered animals with internal skeletons of bone or cartilage, a dorsal tubular nerve cord, pharyngeal gill slits, and a notochord at some time during the life cycle are classified as chordates or Chordata.

38. Localized areas of the brain have specific functions.

39. The skeleton is the framework of an organism within which soft, easily damaged organs are protected and on which muscles are attached.

40. Warm-blooded animals may expand or contract blood vessels in a specific area as a part of their temperature control mechanism.

41. Each species of warm-blooded animals has a body temperature range which is normal but varies with individuals.

42. The temperature of warm-blooded animals is controlled by the organism, not its surroundings.

43. Some warm-blooded animals may cool themselves by formation of perspiration on the body surface or tongue which evaporates and cools the animal.

44. Fins of fish are used to control and direct locomotion.

## II. Living Things

### C. Ecology

Physical and biotic factors

1. The study of the interrelation of all living and non-living things in an environment is ecology.

2. The study of ecology helps the student understand the complexity of environmental relations.

3. The science of paleontology seeks to furnish information about some of the organisms which have lived on the earth.

4. As the environment on the earth's crust changed during the ages, forms of life disappeared.

5. Fossils in the earth's crust indicate that many forms of life developed, flourished and disappeared from the earth during the past ages.

6. Each physical factor of an environment varies within certain limits.

7. Land habitats are usually classified on the basis of precipitation, topography, soil make-up, temperature, humidity, light intensity, direction and velocity of prevailing winds.

8. The individual factors of the total environment may vary within limits but the environment becomes lethal to a species if any factor varies beyond the maximum tolerance of that species.

9. Most organisms thrive only in habitats where the physical factors vary slightly.

10. Very few organisms can thrive in habitats having great changes in physical factors.

11. Certain optimal conditions of pressure, temperature, moisture and light as well as supplies of food and oxygen are essential to the life of most animals.

12. The limits of oxygen and carbon dioxide tolerance are very narrow for most living things.

13. Some living things are very sensitive to rapid changes in temperature.

14. Two areas having the same annual average temperature may support different organisms due to differences in their extremes and variation of temperatures, the rapidity of the temperature fluctuation, and the duration of any specific temperature.

Physical and biotic factors (continued)

15. Many organisms are sensitive to pressure changes.

16. Some living things require permanent air sacs and air cavities.

17. Most organisms are adapted to live in habitats of very limited pressure changes.

18. Many living organisms are so sensitive to pressure changes that may exist in very limited areas.

19. The water requirements for living things vary with the species and the environment.

20. Too much or too little water in an environment will change a habitat and make it unsuitable for many of its inhabitants.

21. Two areas having the same annual precipitation may support very different organisms due to the frequency and duration of the precipitation.

22. Water environments contain different percentages of salts.

23. All living things require light directly or indirectly for a continuation of life.

24. Some plants and animals do not require light in order to live.

25. Different organisms have different light requirements as to intensity, duration, and frequency of exposure.

26. Varying amounts of sun and shade are optimum for certain species of plants.

27. All habitats are gradually undergoing change.

28. The biotic changes which are constantly taking place in any ecological community are called successions.

29. There is a progressive succession of different species of living things within an area.

30. In biological succession each change produced by an organism modifies the environment.

31. Decaying organic material usually increases the fertility of a lake or a field.

32. Lakes and ponds are gradually filled in with vegetation and decayed organic material.

Physical and biotic factors (continued)

33. Most habitats change rapidly until a climax is reached.

34. After an ecological climax is reached the factors of a given habitat fluctuate very slightly.

35. Stable ecological communities are the result of long periods of growth and development.

36. Even in a climax environment the equilibrium of a habitat is dynamic.

37. In order to provide for the continuity of species in any environment, usually many young are produced since only a few survive.

38. Because of cyclic changes in a habitat it may be desirable for an organism to develop and reproduce in a brief period of time.

C. Ecology

Relationship of organism to environment

1. Most living things are limited to rather specific habitats.

2. When the needs of an animal cannot be provided in a habitat, some animals migrate to a related habitat for survival.

3. Xerophytes and xerozoa can exist on a minimum amount of water; however, they still require some water for life.

4. During hibernation and/or estivation the body functions slow down in the organism.

5. The ground roots of a plant usually help hold it upright.

6. Some plants develop adventitious prop roots.

7. Most hydrophytes and hydrozoa require large quantities of water.

8. Plants of various sizes, heights and complexities are found in most habitats.

9. Living things are able to adapt to certain minor changes in their environment.

10. Some body structures are more efficient for a particular purpose than others.

11. Plant life in any habitat has a tendency to stratify and the amount of sunlight reaching lower levels becomes decreasingly intense.

12. Usually the root system of a plant below the ground is as extensive as the system of branches and leaves above the ground.

13. Only those plants whose young can develop in shade continue to inhabit a dense forest area.

14. There are many environmental factors which control the types of plant and animal life in any habitat.

15. Some organisms are able to survive during long periods of unfavorable conditions.

16. Spores are produced by many of the simpler species of plants and/or animals to permit survival during adverse conditions.

17. When unfavorable conditions exist, disease-causing bacteria may encyst.

Relationship of organism to environment (continued)

18. The population of a species in an area is largely determined by environmental conditions which may vary from year to year.

19. Many low plants of the forest bloom before leaves develop in the taller vegetation.

20. Most hardwood forests have three or four layers of vegetation:
    a. highest -- mature trees;
    b. next -- maturing trees;
    c. 3' - 5' -- seedling, saplings, shrubs;
    d. lowest -- forest floor plants.

21. Some plants have modified structures which enable them to grow without contact with the soil (epihytes).

22. Living things occur in areas that are favorable to their survival.

23. Each organism has an optimum habitat.

24. Organisms which appear to thrive in a given environment are usually suited to that environment.

25. Most of the alimentary canal furnishes optimum conditions for bacterial development.

26. When optimum conditions exist, more of a species survive.

27. Plants and animals may exist but do not thrive in environments which provide minimal conditions for living.

28. Some plants require special types of soil.

29. The characteristics of a soil determines the plants which will flourish in it.

30. Some simpler plants and animals are able to encyst in order to remain alive during periods of adverse conditions.

31. Physical barriers affect the dispersion of most species.

32. Physical barriers may localize some species.

33. Physical barriers appear to have very little if any influence on the dispersion of some species.

34. The degree to which a physical barrier affects the dispersion of a species is dependent upon the size of the barrier.

Relationship of organism to environment (continued)

35. Living things may be dispersed by physical and biotic factors in an environment.

36. Many aquatic food chains begin with the algae.

37. Removal of a link in any food chain disturbs the natural balance.

38. All living organisms have other living things which compete with them for the available energy in any area or environment.

39. An organism may overpopulate an area if it has few natural enemies.

40. A given area of a habitat will support only a limited amount of life.

41. The bacteria which cause decay help to remove the waste materials on the surface of the earth and thus return elements to the soil, water and air.

42. All living things can store food within their bodies.

43. A few animals have specialized internal tissues which can store water.

44. Interaction of plants and animals with their biotic and physical environments tend to produce a dynamic equilibrium in nature.

45. An organism which continues to exist in a specific environment must be able to compete successfully with all other organisms in that community.

46. Some organisms must live in close contact with other organisms yet are not parasitic (commensals, mutuals).

47. Some species of animals become gregarious for mutual benefit.

48. Some species of animals are gregarious only at certain seasons.

49. Some animals which usually live as hermits or in pairs become gregarious while moving to a related habitat.

50. Many animals apparently have a warning signal.

51. There are a few cases where two or more different species of animals live together in close association but do not interfere with each others activities.

52. Some plants require specific insect pollenators.

Relationship of organism to environment (continued)

53. Animals are absolutely dependent on plants because photosynthesis, nitrogen fixation, and production of vitamins are fundamental synthetic processes peculiar to plants.

54. The kinds and amount of plant life of an area usually determine the kinds of animal life in that area.

55. When a new species is introduced into an area, drastic changes in population may occur.

56. The removal of only one kind of living thing from an environment may cause great changes in the total environment.

57. Lichens are composite organisms usually consisting of a fungus and an alga living symbiotically.

58. Some lower organisms live as parasites on other organisms and are pathogenic.

59. Tapeworms, hookworms and trichina are among the parasitic worms living on higher animals.

60. All species of a specific genus do not thrive in the same habitat.

61. Thorns and thorn-like structures on stems and leaves make some plants less palatable as a forage crop.

62. Nitrogen fixation bacteria which usually live on the roots of legumes are able to form soil nitrates from the nitrogen of the air.

## II. Living Things

### D. Plant and Animal Economics

1. Some biological materials are used by man to aid him in his daily work.

Chlorophyll-bearing plants directly or indirectly produce all the good in the world.

3. The derivatives of some plants may be used to provide drugs, dyes, flavors, and perfumes.

4. Certain processed biological materials are used for medication.

5. Most mushrooms are safe to eat, but some are very poisonous.

6. Fermentation of sugar by yeasts is important in the baking and brewing industries.

7. The quality of some foods is changed by bacterial fermentation but most of the food value is retained.

8. Algae, especially the blue-green algae, are frequently responsible for undesirable flavors in fresh water supplies.

9. Man grows and maintains living things in definite areas that are favorable to their survival.

10. Man seeks to improve useful living things by discovering, selecting and/or developing those most suited to his needs.

11. Some varieties of domesticated plants and animals are crossbred to develop more desirable characteristics in hybrids.

12. Man can make use of the principle of biological enemies to help control the environment for economically important living things.

13. Plant and/or animal enemies may be introduced to prevent overpopulation of a species.

14. Diseases of plants and animals usually decrease productivity and virility.

15. Some pathogenic fungi on plants produce easily recognizable symptoms.

16. Pathogenic fungi on plants include molds, mildews, rusts and smuts.

17. Most contagious diseases of plants and animals are caused by pathogens which are fungi.

D. Plant and Animal Economics (continued)

18. Harmful bacteria are usually killed by subjecting them to prolonged high temperatures or certain chemicals (bactericides).

19. Some chemicals known as antiseptics may be used to cleanse a wound and inhibit the growth of bacteria.

20. Most bacteria are very sensitive to ultraviolet radiation.

21. The indiscriminate use of X-rays for diagnosis or treatment is dangerous to living organisms.

22. When an organism combats disease, it expends abnormal amounts of energy which causes a weakened condition.

23. The economic level of a civilization requires control of forces which destroy natural resources.

24. Excessive lumbering, fishing and hunting cause serious population depletion among some kinds of wildlife which can be restored only in part by large-scale replacements from tree farms, fish hatcheries, and game farms and refuges.

25. Fibrous root systems tend to prevent wind and water erosion.

26. The natural dynamics and balances among living things are disrupted by man's increase in population.

27. In American civilization, every individual is important and should have the opportunity to participate in society's division of labor.

C. Ecology

Dependence of man on biotic and physical factors

1. Primitive man was very dependent upon his local habitat.
2. Primitive man spent most of his time producing and securing the necessities of life from environmental resources.
3. Only man is able to fit himself to his environment.
4. Man is not able to adjust to extreme changes in environment but he can modify his immediate environment sufficiently to permit extended existence.
5. Man's comfort and success may increase as he learns to control environmental factors.
6. Modern man may live nearly independently of a local undesirable habitat for a period of time.
7. Because of the division of labor in modern civilization much effort and expense is used to modify our environment for convenience and luxury of leisure.
8. Undesirable factors in the environment of man are often tolerated or ignored.
9. A thorough knowledge of all physical and biological factors of an environment is necessary if man is to work with nature.
10. Man must understand the principles which govern the development of natural communities if he is to successfully replace those which have been destroyed.
11. Man may disperse living things beyond their natural barriers.
12. If it is understood that environmental problems are extremely complex, decisions are more apt to be left to qualified specialists.
13. Ecologists through research frequently discover that control measures which seem practical and necessary to many people are in error.
14. A working knowledge of the principles of ecology contributes to the success of a farmer.
15. In our organized society type of civilization there is a great deal of division of labor in securing the necessities of life from environmental resources.

Dependence of man on biotic and physical factors (continued)

16. Plant and/or animal enemies may be introduced to prevent overpopulation of a species.

17. To maintain an optimum number of organisms in a given environment, controlled harvesting is necessary.

18. The elimination of an undesirable organism or a group of undesirable organisms from a biological community does not necessarily improve that community.

19. Antiseptics and disinfectants are chemicals very often used in controlling bacteria.

20. The use of poisons as insecticides may affect the bird and fish populations in an area.

21. During harvesting and removal of crops many essential elements which can be replaced with proper fertilizers are partially removed from the soil.

22. The fertility of a lake or soil may be increased as minerals and organic material are added.

## II. Living Things

### E. Human Body

1. Most living tissues of the body require an almost constant environment.

2. Most organs of the human body are made up of many structural and functional parts.

3. An excessive increase or decrease of the water content of the human body may be lethal.

4. Proper amounts of certain minerals and proteins are necessary in daily diets.

5. Minerals in relatively small amount are necessary for normal growth and development of the human body.

6. The human body requires vitamins, amino acids, fatty acids and minerals for normal growth and development.

7. In the human body the digestive system simplifies foods and makes them available.

8. Although the amounts of organic nutrients, vitamins and minerals taken into the body may be adequate, specific amino acids, fatty acids, vitamins and minerals may be lacking.

9. If a diet does not contain a sufficient amount of organic nutrients, vitamins, minerals and water, deficiency diseases may develop.

10. The human body may store carbohydrates and fats but not protein.

11. The liver contributes to the digestion of fats by secretion of bile into the small intestine.

11A. The liver forms, stores and releases glycogen (animal starch), and converts most metabolic wastes into urea.

12. The amount of available blood sugar in the body is dependent upon the chemical equilibrium in the liver.

13. Animal protein contains a greater number of the essential amino acids than do like amounts of plant protein.

14. In order for the body to build human proteins, certain essential amino acids must all be present at the same time.

15. In order for the process of deamination to occur in the liver, arginine (a special amino acid) must be present.

E. Human Body (continued)

16. There are some fluids which circulate to only specific parts of the body while others circulate throughout the entire body.

17. Intercellular fluids which do not return directly to the blood stream go into lymphatic vessels.

18. Lymphatic circulation is a partially closed system which collects digested fats and wastes from the small intestine and intercellular fluids and empties them into the subclavian veins.

19. Muscular activity aids in the return of blood and lymph to the heart.

20. A decrease in the amount of oxygenated blood reaching the brain usually results in a change of the efficiency of mental processes.

21. During strenuous exercise the red blood count increases.

22. Any decided variation from normal blood pressure may have a great effect on flow of blood.

23. White corpuscles and substances produced by the blood or introduced into the blood (often called antibodies) are used by the body as defense against infection.

24. So-called antibodies in the bloodstream are not definitive structures but are proteins.

25. Clotting of blood is the result of complex chemical and physical changes.

26. During the production of the enzyme prothrombin by the liver, an adequate supply of vitamin K is necessary.

27. Normally human beings have adequate amounts of vitamin K.

28. Drugs are available which usually prevent clotting.

29. Anticoagulant drugs are available which, if used, usually control clotting of blood.

30. Buffers are substances which help maintain a state of chemical equilibrium so that the concentration of certain materials cannot vary beyond specific limits in the body (tears, blood).

31. The ability of a red blood corpuscle to carry oxygen is dependent upon chemical equilibriums.

E. Human Body (continued)

32. Enzymes, vitamins and hormones are chemical regulators (stimulators and suppressors) of the reactions that occur in the human body.

33. Vitamins, hormones and enzymes are substances which control some body functions.

34. Vitamins help regulate some body activities.

35. Secretions are the products of glands, some of which are collected in ducts and some of which empty directly into the bloodstream.

36. Hormones regulate some specific chemical reactions in an organism.

37. In general, duct glands control a specific local chemical activity in an organism, while endocrine glands control specific activities throughout the organism.

38. The endocrine (ductless) glands secrete their hormone directly into the bloodstream.

39. Duct glands (exocrine) produce secretions which aid in the control of specific chemical activities in any organism.

40. A normal characteristic of living muscle tissue is that it is constantly in a state of partial contraction.

41. There are various types of muscles, each of which is especially adapted to certain activities.

42. Most skeletal muscles work in pairs, as one contracts the other relaxes.

43. Repeated rapid stimulation of muscles without adequate recovery periods results in fatigue.

44. During strenuous exercise the concentration of lactic acid in the muscle tissues increases greatly.

45. During rest after strenuous exercise the increased lactic acid concentration in muscle tissues gradually decreases.

46. During periods of rest following activity, the body may rid the tissues of accumulated metabolic wastes and replenish the oxygen content.

47. Recovery from muscular fatigue is said to be accomplished when wastes are removed and chemical equilibrium is re-established.

48. The nervous system of man is composed of three closely related divisions called central, peripheral and autonomic.

E. Human Body (continued)

49. The central nervous system of man consists of the brain and spinal cord.

50. The peripheral nervous system consists of nerves which carry impulses from the sense organs to the spinal cord (sensory or afferent nerves) and from the spinal cord to the muscles (motor or efferent nerves).

51. The autonomic nervous system consists mainly of two rows of ganglia, one on either side of the spinal column.

52. The autonomic nervous system controls vital involuntary functions.

53. Localized areas of the brain have specific functions.

54. There are some parts of the body which cannot receive certain types of stimulation.

55. The common instincts of man are conventionally grouped into defensive, nutritive, reproductive and social.

56. Learning is the establishment of new responses to specific stimuli.

57. Habits are acquired by the repetition of a learned response to a stimulus.

58. Habits tend to reduce the amount of mental effort needed to perform a specific task.

59. In order to change a habit, more energy is required.

60. Man can change his instinctive or learned responses to stimuli.

61. Early training and parental care cause human instincts to become modified and supplanted by habits.

62. Few responses to stimuli are made during sleep.

63. Reduction in number of stimuli and lack of response to stimuli tend to induce sleep.

64. During sleep, the rate of deterioration due to activity is decreased, enabling growth and repair to help restore equilibrium.

65. The human body is more resistant to disease if it secures optimum amounts of food, oxygen, rest and exercise.

66. Some diseases are organic and functional disorders, which are not caused by microorganisms or parasites.

E. Human Body (continued)

67. Body resistance to disease may be natural or acquired.

68. Under competent professional guidance the use of drugs and innoculations decreases the incidence and severity of some diseases.

69. The human body has structures and adaptations which prevent disease-causing organisms from gaining entrance into the body proper.

70. The human body's defenses against disease include skin, mucous membranes, white corpuscles and blood materials usually called antibodies.

71. Formation of scar tissue sometimes protects the body from further infection.

72. The feeling of weakness following a disease may be partially due to decreased food intake, large amount of energy expended in overcoming the disease, or a lack of regular muscular activity.

73. Some animal disease causers injure man directly.

74. Excrement from the bodies of people contains many pathogenic organisms.

75. Some diseases are caused by protozoans rather than by viruses or bacteria.

76. Certain flies and/or mosquitoes act as carriers in the transmission of specific diseases.

77. To a few people, the sting or bite of an animal, which is usually thought to be harmless, may be serious or even fatal (a bee sting).

78. Some insects and arachnids carry disease causing organisms and transmit them to healthy people.

79. Tapeworms, hookworms and trichina are among the human parasitic worms.

80. Some people who do not have symptoms of a specific disease may carry that disease and transmit it to others.

81. A person who inherits hemophilia may have normal amounts of prothrombin, calcium and platelets in his blood.

82. The addition of chemical ions to food and/or water has reduced or practically eliminated some human defects.

II. Living Things

F. Aesthetic Values

1. Man is a product of heredity, environment and training.
2. The use of spices varies with man's customs and tastes.
3. The desire for obtaining and controlling the supply of spices has greatly influenced world history.

REFERENCES

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### 1. Methods and Techniques

American Optical Company 1962

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American Optical Company Single Copy Free

This is a useful booklet with numerous ideas and aids for use with the microscope. It includes maintenance and care of the microscope.

Berman, William 1961

HOW TO DISSECT

Sentinel Books $1.00

Clear, concise beginners directions for the dissection of night crawlers, crayfish, grasshoppers, starfish, squid, sharks, frogs and the gladiolus.

Brandwein, Paul F., Jerome Metzner, Evelyn Morholt,
Anne Roe and Walter Rosen 1962

TEACHING HIGH SCHOOL BIOLOGY: A GUIDE TO WORKING WITH POTENTIAL BIOLOGISTS

The American Institute of Biological Sciences
From BSCS Bulletin No. 2 $3.50

This volume and the companion ones, "*High School Biology: Biological Investigations for Secondary School Students, Volume I and Volume II*" have been prepared for use by teachers who are engaged in guiding the young investigator.

Feldman, Solomon 1962

TECHNIQUES AND INVESTIGATIONS IN THE LIFE SCIENCES

Holt, Rinehart & Winston (paper) $2.72

Describes in detail, various techniques used in biological research and outlines investigations for students to carry out using these techniques.

Teaching of Biology - Methods and Techniques (continued)

Goltsoff, Paul S., Frank E. Lutz, Paul S. Welch, James Needham 1937

CULTURE METHODS FOR INVERTEBRATE ANIMALS

Dover $2.85

Prepared as an aid to studies that require living animals in continuous supply. Many individuals contributed their tested recipes and methods of culturing.

Goldstein, Phillip 1957

HOW TO DO AN EXPERIMENT

Harcourt, Brace and Company $2.60

A self teaching guide to experimental work. The handbook explains the "scientific methods" and gives examples of how they have been used. For the junior or senior high school science student who wants to expand his knowledge by exploring any phase of any science at his own pace.

Lawson, Chester, A., Editor, and Richard E. Paulson 1960

LABORATORY AND FIELD STUDIES IN BIOLOGY - A Sourcebook for Secondary Schools - Teacher's Edition

Holt, Rinehart and Winston $3.40

This book challenges the young biology student to learn factual material, methods, and problems of modern biology. The exercises in this sourcebook cover every aspect of modern biology; the organism in relation to its environment; concepts of biological classification; the chemical aspects of biology; how the organism obtains and uses matter and energy; the maintenance of the individual and of the species; and the evolution of organisms.

Lee, Addison E., Richard E. Barthelmy, James R. Dawson 1964

EQUIPMENT AND TECHNIQUES FOR THE BIOLOGY TEACHING LABORATORY

D.C. Heath & Co. $1.95

Vividly presents learning through observation--teaching by demonstration as the most effective way to instruct prospective teachers in the biological sciences. Stresses the importance of the biological sciences as an educational subject--necessary in solving the numerous crises confronting human society. Great emphasis is placed on conservation and ecology.

Teaching of Biology - Methods and Techniques (continued)

Miller, David F. and Glenn W. Blaydes 1962

METHODS AND MATERIALS FOR TEACHING THE BIOLOGICAL SCIENCES

McGraw-Hill $7.95

Intended as a source book for secondary school teachers, but valuable also for their students who are working on individual research projects and special assignments.

Morholt, Brandwein and Joseph 1958

TEACHING HIGH SCHOOL SCIENCE: A SOURCEBOOK FOR THE BIOLOGICAL SCIENCES

Harcourt, Brace & World $6.75

Much to offer in laboratory activities, techniques, procedures, demonstrations, collecting specimens and culture hints. It includes how to prepare chemical solutions for suggested learning activities.

Schwab, Joseph J. 1963

BIOLOGY TEACHERS' HANDBOOK (Biological Sciences Curriculum Study)

Wiley $7.00

This manual and resource book explains the BSCS approach to the teaching of biology as a process of scientific inquiry. Compilation of materials designed to improve biological education at the secondary school level. It compares and explains the content of the Blue, Green, and Yellow Versions.
This is an indispensable manual for all teachers of biology, irrespective of whether they are using BSCS texts. It should be owned by every high school library as a resource book for talented students working on individual projects.

Teaching of Biology

2. Experiment and/or Project Books

American Institute of Biological Sciences, BSCS, 1963 and 1965

RESEARCH PROBLEMS IN BIOLOGY, Series 1, 2, 3, 4

Doubleday & Co. (Anchor Books) paper $ .95

This series of four paperbound books include one hundred sixty (40 each volume) research problems in biology which are offered to the biology student as a means of developing the art of investigation. These volumes are the work of the Gifted Student Committee of BSCS which was chaired by Dr. Paul F. Brandwein.

Barthelemy, Richard E., James R. Dawson, Jr., Addison Lee 1962

HIGH SCHOOL BIOLOGY: Equipment and Techniques for the Biology Teaching Laboratory

D. C. Heath & Co. $1.95

Vividly presents learning through observation--teaching by demonstration as the most effective way to instruct prospective teachers in the biological sciences. Stresses the importance of the biological sciences as an educational subject--necessary in solving the numerous crises confronting human society. Great emphasis is placed on conservation and ecology.

Berman, William 1963

EXPERIMENTAL BIOLOGY

Sentinel Books $1.00

Information for laboratory activities and research projects. Many are open-ended and can be used to supplement or enrich the laboratory.

Feldman, Solomon 1962

TECHNIQUES AND INVESTIGATIONS IN THE LIFE SCIENCES

Holt, Rinehart & Winston (paper) $2.72

Describes in detail, various techniques used in biological research and outlines investigations for students to carry out using these techniques.

Teaching of Biology - Experiment and/or Project Books (continued)

Harrold, Lloyd L. 1963

WATER INTAKE BY SOIL (Experiments for High School Students)

U.S. Department of Agriculture $ .10
Miscellaneous Publication No. 925

A ten page pamphlet which suggests a few learning experiences.

Kalmus, H. 1960

101 SIMPLE EXPERIMENTS WITH INSECTS

Doubleday & Co. $2.95

Suggested experiments for the younger biology student and the amateur naturalist that will enable him to explore some aspects of the natural history and physiology of insects. Includes a list of biological supply houses.

Lawson, Chester A., Editor, and Richard E. Paulson 1960

LABORATORY AND FIELD STUDIES IN BIOLOGY - A Sourcebook for Secondary Schools

Holt, Rinehart and Winston $2.05

This book challenges the young biology student to learn factual material, methods, and problems of modern biology. The exercises in this sourcebook cover every aspect of modern biology; the organism in relation to its environment; concepts of biological classification; the chemical aspects of biology; how the organism obtains and uses matter and energy, the maintenance of the individual and of the species; and the evolution of organisms.

Witherspoon, James D. and Rebecca H. Witherspoon 1960

THE LIVING LABORATORY

Doubleday & Co. $3.95

An illustrated book of safe, exciting projects and experiments for students and the amateur scientist of any age. It serves to acquaint students with good research techniques and provides an understanding of broadly applicable principles.

3. Life Nature and Life Science Library Series

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3. Life Nature and Life Science Library Series (continued)

Animal Behavior - Niko Tinbergen

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A Guide to the Natural World (Index) - Maitland A. Edey, Ed.

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3. Life Nature and Life Science Library Series (continued)

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Weather - Philip D. Thompson and Robert O'Brien

Flight - H. Guyford Stever and J. Haggerty

Ships - Edward V. Lewis and Robert O'Brien

Man and Space - Arthur C. Clarke

The Scientist - Henry Margenau and David Bergamini

Giant Molecules - Herman F. Mark

The Planets - Carl Sagan and Jonathan Norton Leonard

The Engineer - Clifford C. Furnas and Joe McCarthy

Light and Vision - Conrad Mueller and Mae Rudolph

The Physician - Russel V. Lee and Sarel Eimerl

Sold by: SILVER BURDETT COMPANY
Department T-L
460 South Northwest Highway
Park Ridge, Illinois 60068
$3.95 each

4. Some College Textbooks

Frobisher, Martin 1962

FUNDAMENTALS OF MICROBIOLOGY

W.B. Saunders Co. $8.00

Thorough coverage of basic principles of microbiology; excellent illustrations

Fuller, Harry J. and Oswald Tippo 1954

COLLEGE BOTANY

Holt, Rinehart and Winston $9.95

An almost encyclopedic and phylogenetic approach to the study of botany, with excellent sections on morphology, physiology, and ecology. Not the type of book that goes out-of-date quickly; hence a valuable reference.

Hegner, Robert W. and Karl A. Stiles 1957

COLLEGE ZOOLOGY

Macmillan $8.25

An excellent text which proceeds from the protozoa to the higher vertebrates in a comprehensive morphological treatment. Includes sections on basic biological principles, organic evolution, and a glossary

Milne, Lorus and Margery Milne 1959

ANIMAL LIFE

Prentice-Hall $7.95

A revision and enlargement of the zoology section of a previous book by these authors. As before, the numerous photographs and illustrations combine with a concise and accurate text to produce an excellent work.

4. Some College Textbooks (continued)

Simpson, George G., Colin S. Pittendrigh, Lewis H. Tiffany 1957

LIFE, AN INTRODUCTION TO BIOLOGY

Harcourt, Brace & World $10.00

A well illustrated book, for reading and for reference. Its value is to the individual and to the family as it explains human bioligy in a biological setting.

Storer, Tracy I., Robert L. Usinger 1957

GENERAL ZOOLOGY

McGraw-Hill $8.50

An outstanding and complete college text. Part I discusses general principles of animal biology and Part II is an introduction to the classification and physiology of each group of animals.

Wilson, Carl L., Walter E. Loomis 1962

BOTANY

Dryden Press, Inc. $8.75

An outstanding and colorful presentation of the basic botanical concepts.

Teaching of Biology

5. A Partial List of Magazines

A. For Teachers:

"American Biology Teacher" (Monthly)
$3.75 per year
Interstate Press
19 North Jackson Street
Danville, Illinois

"Carolina Tips" (Monthly)
Free
Carolina Biological Supply Company
Burlington, North Carolina

"Journal of Research in Science Teaching" (Quarterly)
$10.00 per year included with NARST membership
John Wiley & Sons, Inc.
440 Park Avenue South
New York, N.Y. 10016

"School Science and Mathematics" (Monthly, except July, August and September.)
$4.50 per year
Box 408
Oak Park, Illinois

"Science Teacher" (Monthly 8 issues, except January, June, July and August.)
$6.00 per year, regular member
$10.00 per year, sustaining member
National Science Teachers Association
1201 - 16th Street, N.W.
Washington, D. C.

B. For Teachers and Pupils:

"Audubon Magazine" (Bi-monthly)
$6.50 with membership
National Audubon Society
1000 Fifth Avenue
New York, N.Y. 10028

B. For Teachers and Pupils (continued)

"Conservation Volunteer" (Bi-monthly)
Free
Minnesota Department of Conservation
Centennial State Office Building
658 Cedar Street
St. Paul 1, Minnesota

"Cornell Science Leaflet" (Quarterly)
$1.00 per year - four issues
New York State College of Agriculture
Cornell University
Ithaca, New York

"Current Science" (weekly)
$1.40 per year single subscriptions
.35 a semester or 70¢ in quantities 7-9
American Education Publication
The Wesleyan University Press
1250 Fairwood Avenue
Columbus 16, Ohio

"The Minnesota Journal of Science" (quarterly)
$5.00 including membership
Minnesota Academy of Science
1821 University Avenue
St. Paul 4, Minnesota

"National Geographic Magazine" (monthly)
$8.00 per year
National Geographic Society
1146 - 16th Street N.W.
Washington 6, D.C.

"Natural History Magazine" (Bi-monthly, June to September)
$5.00 per year
American Museum of Natural History
79th Street and Central Park West
New York, N.Y. 10024

"Science and Math Weekly" (weekly)
$ .50 a semester or $1.00 per year in quantities of 10-12,
single subscription, $2.00 per year
American Education Publications
The Wesleyan University Press, Inc.
1250 Fairwood Avenue
Columbus 16, Ohio

B. For Teachers and Pupils (continued)

"Science Digest" (monthly)
$3.50 per year
959-8th Avenue
New York, N.Y. 10019

"Science News Letter" (weekly)
$5.50 per year
Science Service
1719 N Street N.W.
Washington 6, D.C.

"Science World"
Edition 1: Biweekly, 16 per semester, for grades 7-9
In groups $1.25/school year or 85¢/semester
Edition 2: Biweekly, 16 per semester, for grades 10-12
In groups $1.50/school year or $1.00/semester
Single subscription $2.00 year, Teachers edition, $4.50 school year
From Scholastic Magazines, Inc.
33 West 42nd Street
New York, N.Y. 10036

"Scientific American" (monthly)
$5.00 per year
415 Madison Avenue
New York, N.Y. 10017

"Turtox News" (monthly)
Free
General Biological Supply House
8200 South Hoyne Avenue
Chicago 20, Illinois

"Ward's Bulletin" (monthly)
Free
Ward's Natural Science Establishment, Inc.
P.O. Box 1712
Rochester 3, N.Y.

"Welch General Science and Biology Digest" (quarterly)
Free
W.M. Welch Scientific Company
1515 North Sedgwick Street
Chicago 10, Illinois

# BSCS PUBLICATIONS

## BSCS publications available through commercial distributors:

Blue Version–*Biological Science: Molecules to Man:* Houghton Mifflin Co., 110 Tremont St., Boston, Mass. 02107.
Green Version–*High School Biology, BSCS Green Version:* Rand McNally & Co., P.O. Box 7600, Chicago, Ill. 60680.
Yellow Version–*Biological Science: An Inquiry Into Life:* Harcourt, Brace & World, Inc., 757 Third Ave., New York, N. Y. 10017.
Second Course–*Biological Science: Interaction of Experiments and Ideas:* Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632.
BSCS Special Materials–*Biological Science: Patterns and Processes:* Holt, Rinehart and Winston, Inc., 383 Madison Ave., New York N. Y. 10017.
BSCS Version Quarterly Tests (Available through the version publishers.)
BSCS Comprehensive Final Exam for all versions: The Psychological Corp., 304 E. 45th St., New York, N.Y. 10017.
Laboratory Blocks–*Plant Growth and Development; Animal Growth and Development; Microbes: Their Growth, Nutrition and Interaction; The Complementarity of Structure and Function; Field Ecology; Regulation in Plants by Hormones–A Study in Experimental Design; Animal Behavior; Life in the Soil;* and *Genetic Continuity:* D. C. Heath & Co., 285 Columbus Ave., Boston, Mass. 02116.
Equipment and Techniques for the Biology Teaching Laboratory–*Innovations in Equipment and Techniques for the Biology Teaching Laboratory:* D. C. Heath & Co., 285 Columbus Ave., Boston, Mass. 02116.
Teachers' Handbook–*Biology Teachers' Handbook:* John Wiley & Sons, Inc., 605 Third Ave., New York, N.Y. 10016.
Biological Investigations for Secondary School Students–*Research Problems in Biology: Investigations for Students, Series One, Two, Three,* and *Four:* Doubleday & Co., 575 Madison Ave., New York, N.Y. 10017.
BSCS Pamphlet Series: (24 titles) D. C. Heath & Co., 285 Columbus Ave., Boston, Mass. 02116.
BSCS Techniques Films (for teacher preparation): Thorne Films, Boulder, Colo. 80302, 16 mm sound; Ealing Corporation, Cambridge, Mass., 01922, 8 mm loops, silent.

## Other materials available from the BSCS, P.O. Box 930, Boulder, Colorado 80302:

BSCS Bulletin Series: (3 titles).
*BSCS NEWSLETTER.*
BSCS Special Publication Series (Concerned with teacher preparation).
Laboratory Blocks, experimental editions.
*BSCS INTERNATIONAL NEWS NOTES.*
BSCS Single Topic Films: Series in preparation; distributors have not yet been designated.
BSCS Information Film: *The Story of BSCS* (Revised). (Free loan upon request.)
Supplies and Equipment for BSCS Biology: BSCS NEWSLETTERS 21 and 25, and *BSCS Bulletin No. 3.* There are no "official" or "recommended" BSCS suppliers.

*For books distributed by the BSCS, we regret that no discounts can be given and no examination copies can be sent.*

## Introduction to Science

Asimov, Isaac 1964

A SHORT HISTORY OF BIOLOGY

Garden City (Paper) $1.25

An authoritative, well-written outline which explains the basic trends and developments in biology from the Greeks to the most recent theories on the origin of life. Significant discoveries, dramatic controversies, and conflicting theories are highlighted; important scientists are identified and their contributions to biology briefly evaluated. Good introduction for the general reader and a useful review for the student.

Knobloch, Irving W. (Ed.) 1948

READINGS IN BIOLOGICAL SCIENCE

Appleton-Century, Crofts, Inc. $3.00

Articles encompassing all the basic phases of biology, selected for their ability to stimulate and develop the reader's thought.

Locy, William A. 1958

BIOLOGY AND ITS MAKERS

Holt, Rinehart & Winston $6.95

A non-technical account of the rise and progress of biology...., indicating the sources of biological ideas and the main currents along which they have advanced.

Moore, Ruth 1960

THE COIL OF LIFE: THE STORY OF GREAT DISCOVERIES IN THE LIFE SCIENCES

Knopf $5.95

Describes the discoveries of the last 200 years in biology, biochemistry, and allied disciplines, that have contributed to our knowledge and understanding of the components of living tissue; bibliography included.

Introduction to Science (continued)

Shippen, Katherine B. 1955

MEN, MICROSCOPES, AND LIVING THINGS

Viking $3.50

Aristotle, Darwin, Mendel, and others have contributed to mankind's knowledge of the living things around him. Their stories are told herein with realism.

## II. Living Things

### A. Life and life processes

Arey, Leslie B. 1954

DEVELOPMENTAL ANATOMY

W.B. Saunders Co. $9.50

A detailed text on human embryology; includes laboratory directions for the study of chick and pig.

Beck, Stanley D. 1964

ANIMAL PHOTOPERIODISM

Holt, Rinehart and Winston $2.50
(paper) 1.25

A clear, concise, nontechnical introduction to a comparitively new field of scientific research. Relationship of day length to animal growth, development, and behavior. Experiments involving biological rhythms in both plants and animals are described, their results, objectives and practical applications explained, and the role played by photoperiod in the migration of birds, hibernation, breeding cycles and natural selection discussed. Bibliography and glossary are included.

Borek, Ernest 1961

THE ATOMS WITHIN US

Columbia University Press $5.00

The biochemists' laboratory is opened to the general reader, giving him a guide to the procedures and accomplishments of biochemistry as well as an introduction to the mechanism of life itself. Winner of the 1961 Thomas Alva Edison Foundation Award.

Carlson, Anton J. and Victor Johnson 1961

THE MACHINERY OF THE BODY

University of Chicago Press $6.50

The science of physiology is described in a way which will prove fascinating to anyone with an inquiring mind and a rudimentary knowledge of chemistry.

II. Living Things - A (continued)

Colin, Edward C. 1956

ELEMENTS OF GENETICS

McGraw-Hill $7.95

Lucid, popular approach to the primary facts, principles and theories of genetics as manifested in plants, lower animals and man. Contains a helpful glossary.

Darwin, Charles 1959

THE VOYAGE OF THE BEAGLE

| | |
|---|---|
| Harper & Row | $4.95 |
| Doubleday & Co. (paper, 1962) | 1.45 |
| Dutton (Everyman's 104) | 2.25 |

As a young biologist, Darwin sailed around the world, making a record of his observations which later led to his theories on evolution. The diary of this voyage is now a science classic.

Downes, Helen R. 1962

THE CHEMISTY OF LIVING CELLS

Harper & Row $9.75

An up-to-date text for students with a background in biology and college chemistry. Part I is historical and explains the properties of solutions and the structure of living forms; Part II deals with the organic constituents of cells; the last part with studies of metabolism. References and good index.

Gerard, R. W. 1949

UNRESTING CELLS

Harper & Row (Paper) $2.25

Written to acquaint the intelligent layman with the analytic aspects of biology; describes the physics, chemistry, and physiology of cells.

II. Living Things A- (continued)

Goldstein, Philip 1964

GENETICS IS EASY

| | |
|---|---|
| Lantern Press | $4.00 |
| Viking (paper) | 1.45 |

A brief but lucid presentation of genetics. Has authoritativeness - presented with simplicity. This edition includes revisions that incorporate modern discoveries and research.

Grumbach, M. C., D. M. Hamilton and R. D. Hotchkiss 1963

CHEMISTRY, CHROMOSOMES AND CONGENITAL ANOMALIES

The National Foundation - March of Dimes -Free in limited quantities

A brief paperback which describes some of the chromosome anomalies which account for various human abnormalities.

Hutchins, Carleen Maley 1961

LIFE'S KEY--DNA: A BIOLOGICAL ADVENTURE INTO THE UNKNOWN

Coward-McCann $2.52

The subject of DNA (deoxyribonucleic acid) is one of the most important and vital areas of interest in contemporary science. This introduction for serious young students will awaken further curiosity and inquiry.

Lasker, Gabriel W. 1963

HUMAN EVOLUTION

Holt, Rinehart and Winston $2.50

An attempt "to explain the source and direction of variation in individuals and groups, past and present" draws its material from archeology, palentology, embryology, and anatomy. Author, assuming that evolution as a fact has been adequately proven, devotes discussion to theories of how it happens. Modern man's relation to lower animals and to various fossil men is explained, also the value of anthropometry, and the nature of racial and hereditary differences.

II. Living Things A (continued)

Marvin, H. M. 1960

YOUR HEART, A Handbook for Laymen

| | |
|---|---|
| Doubleday & Co. | $4.50 |

An informative, clearly written handbook by a heart specialist. Explains in simple terms the nature of heart diseases and disturbances, their effect on the heart's ability to perform its function, types of medical and surgical treatment now available. Each disease and disorder is treated individually; also contains material on such topics as the heart in pregnancy, obesity, effect of smoking on the heart and the doctor-patient relationship.

McElroy, William D. 1964

CELL PHYSIOLOGY AND BIOCHEMISTRY

| | |
|---|---|
| Prentice-Hall | $3.95 |
| (Also paperback) | 1.75 |

Through a study of the chemical changes that occur in cells, a basic understanding of physiology is obtained. High school biology and chemistry are sufficient background for comprehension.

Morowitz, Harold J. 1963

LIFE AND THE PHYSICAL SCIENCES

| | |
|---|---|
| Holt, Rinehart and Winston | $2.50 |

The interrelation between biology and physics and chemistry, a subject which is discussed in its broader aspects by Portmann in "New Paths in Biology" is presented here, in terms of cellular biology. The nature, structure and functions of cells and their component molecules are explained and experimental methods used in biophysical research are described. Will be useful in high school libraries, chiefly to advanced biology students.

II. Living Things· A -(continued)

Reed, Sheldon C. 1963

COUNSELING IN MEDICAL GENETICS

W. B. Saunders $5.50
(Also published as "Parenthood and Heredity" by John Wiley and Sons, 1964, paper, $1.65)

This book and its companion paperback edition, "Parenthood and Heredity" have been received with a great deal of interest by the layman. It is short enough and written in a light enough vein so the medical profession and most high school students will "be introduced to a most important and exciting discipline". Medical genetics is not "a morbid subject full of threats to everyone, but is a new science with hope for all".

Scientific American, Editors of 1957

PLANT LIFE

Simon & Schuster $1.45

Articles explaining the chemistry and genetics behind botany.

Simpson, George C., Colin S. Pittendrigh, Lewis H. Tiffany 1965

LIFE: AN INTRODUCTION TO BIOLOGY

Harcourt, Brace & World $8.95

A college text emphasizing the "principles approach" with supporting data to general biology. Units in ecology, historical geology, evolution, biogeography are well written and indicate the completeness of the book

Waddington, Conrad H. 1956

PRINCIPLES OF EMBRYOLOGY

Macmillan $7.50

The results of experimental analysis of developmental processes in animals and their relation to modern genetics.

## II. Living Things - A (continued)

Wallace, Bruce and Th. Dobzhansky 1963

RADIATION, GENES, AND MAN

Holt, Rinehart and Winston $4.00

A discussion of the genetic problems raised by atomic radiation, including a summary of the known effects on the mutation of genes. For lay readers who know the basic principles of heredity.

Pelczer, J. M. and R. D. Reid 1958

MICROBIOLOGY

McGraw-Hill $8.00

Thorough introductory textbook of microbiology; special attention is given to laboratory methods, physiochemistry and biochemistry. Helpful supplementary material is provided.

Reidman, Sarah R. 1956

OUR HORMONES AND HOW THEY WORK

Abelard-Schuman, Ltd. $2.50

The intriguing story of the discovery and functions of hormones, told in an authoritative but readable manner.

Romer, Alfred Sherwood 1959

THE VERTEBRATE STORY

The University of Chicago Press $7.00

Unfolds the evolution and fossil history of backboned animals, with major emphasis on man himself. This book is a complete revision of Man and the Vertebrates.

Scheinfeld, Amram 1956

THE HUMAN HEREDITY HANDBOOK

Lippincott $3.95

Concise, up-to-date manual of information about heredity in man; most satisfactory for quick reference.

II. Living Things - A (continued)

Scheinfeld, Amram 1963

**THE NEW YOU AND HEREDITY**

**Lippincott $7.50**

**Widely acclaimed for its thoroughness and insight; deals with such fundamental questions as human heredity, intelligence, behavior, abnormalities and evolution.**

## II. Living Things

### B. Classification, general

Buchsbaum, Ralph M. 1948

ANIMALS WITHOUT BACKBONES

University of Chicago Press $6.00

An outstanding introduction to invertebrate zoology for layman and college student alike. Excellent illustrations.

Buchsbaum, Ralph and Lorus J. Milne 1960

THE LOWER ANIMALS: LIVING INVERTEBRATES OF THE WORLD

Doubleday & Company $12.50

A pictorial account and descriptive natural history of outstanding representatives of the invertebrate world, ranging from microscopic radiolarians to giant squids, from spiders on high mountains to sea cucumbers in the ocean deeps.

Christensen, Clyde M. 1965

THE MOLDS AND MAN: AN INTRODUCTION TO THE FUNGI

University of Minnesota Press $4.75
(Also paper) 1.75

A popular science book of exceptional interest and educational value. Includes experiments with fungi and very little on classification. A layman's book on the fungi.

Collins, Henry Hill, Jr. 1960

COMPLETE FIELD GUIDE TO AMERICAN WILDLIFE: EAST, CENTRAL AND NORTH

Harper & Row $6.95

Handbook on birds, mammals, reptiles, fish and seashore life found in the U.S. and Canada east of the Rockies and north of the Carolinas and Oklahoma.

II. Living Things - B (continued)

Fernald, Merritt Lyndon 1950

GRAY'S MANUAL OF BOTANY

American Book Co. $12.50

The standard reference handbook of the flowering plants and ferns of the central and northeastern United States and adjacent Canada.

Gleason, H. A. and Arthur Cronquist 1963

MANUAL OF VASCULAR PLANTS OF NORTHEASTERN UNITED STATES AND CANADA

Van Nostrand $11.75

A portable, accurate reference, suitable for use in the laboratory or the field, this book will serve equally well as a text in courses in taxonomy and systematic botany or as a valuable reference-manual for conservationists, foresters, and others interested in natural history. A General Key is included for identification of plants on a system of classification according to their most easily observed characteristics.

Goldring, Winifred 1960

HANDBOOK OF PALEONTOLOGY FOR BEGINNERS AND AMATEURS, Part I, The Fossils

Paleontological Research Institution
Ithaca, New York (paper) $3.00

This is a well known and useful text on fossils, the phyla of animals and plants including descriptions of the make up of fossils, how to collect, full descriptions with illustrations of the groups.

Gromme, Owen J. 1963

BIRDS OF WISCONSIN

The University of Wisconsin Press $22.50

Superb large portraits on 105 color plates of 238 species of birds common to the Mississippi flyway and the interior of Wisconsin. Additional aids to identification are habitat renderings, characteristic silhouettes, distribution maps and diagrams for the state. Valuable supplement to conventional field handbooks.

## II. Living Things - B (continued)

Harlow, William M. 1959

**FRUIT KEY AND TWIG KEY**

Dover T511 $1.25

Identification of trees and shrubs of eastern North America by fruit and twigs.

Hegner, Robert 1935

**PARADE OF THE ANIMAL KINGDOM**

Macmillan $6.95

Fascinating information of the form, function, and activities of well-known animals. The authors have chosen representatives from each large group in the animal kingdom in order of their complexity from amoeba to man.

Hubbs, Carl L. and Karl F. Lagler 1964

**FISHES OF THE GREAT LAKES REGION**

*Cranbrook Institute of Science* $6.95
(University of Michigan)

A complete guide to the identification of the fishes found in the Great Lakes basin. The basin includes the rivers, lakes, and streams of the entire Midwestern United States; also southern Ontario and Quebec, New England, New York, New Jersey, Pennsylvania, Maryland, Delaware and Virginia. Includes keys to species and subspecies.

Kudo, Richard R. 1966

**PROTOZOOLOGY**

Chas. C. Thomas $15.75
Springfield, Illinois

Unusually good source for basic knowledge on the ecology, morphology, physiology, reproduction, variation, and heredity of the protozoa and on methods for their collection and study. Valuable for students of biology, laboratory workers engaged in identification of unknown specimens and all persons whose work involves familiarity with protozoa. Excellent illustrations.

II. Living Things - B (continued)

LaMonte, Francesca 1958

NORTH AMERICAN GAME FISHES

Doubleday & Co. $4.50

A non-technical guide that will facilitate identification of the fresh-water and salt-water game fishes in North American waters, and bordering seas and oceans. Of major interest to anglers and amateur naturalists.

Levine, Norman 1961

PROTOZOAN PARASITES OF DOMESTIC ANIMALS AND OF MAN

Burgess $5.50

The author has gone to original research on each of the types and species of animal and human parasites. A valuable reference for parasitology.

Lutz, Frank E. 1948

FIELD BOOK OF INSECTS

Putnam $3.95

A standard pocket field guide including most of the commonly observed insects in the United States and Canada.

Portner, C. L. 1960

TAXONOMY OF FLOWERING PLANTS

Freeman $6.75

A presentation of the history, principles, and methods of plant taxonomy with detailed discussions of selected orders and families of Monocotyledons and Dicotyledons. Intended for those who have completed a basic botany course. Includes glossary.

II. Living Things - B (continued)

Roberts, Thomas S. 1960

BIRD PORTRAITS IN COLOR

University of Minnesota Press $5.95

Originally published in 1934 and recently out of print this set of plates (92) is brought back into print with revisions in statements on ranges of species and changes in names to conform to those used by the American Ornithologists' Union. Plates were first used to illustrate the birds of Minnesota but are of use to bird watchers throughout temperate North America east of the Rocky Mountains. Two hundred and ninty-five North American species.

Rothschild, Lord 1961

A CLASSIFICATION OF LIVING ANIMALS

Longmans $5.95

Up-to-date, single-volume classification of the animal kingdom with animal and group index, intended for physiologists, biochemists, biophysicists and biologists.

Simpson, George Gaylord 1961

PRINCIPLES OF ANIMAL TAXONOMY

Columbia University Press $6.00

From the author's long experience in the taxonomy of fossils and of living animals, he has written a detailed introduction to the fundamental principles of animal taxonomy which should be understood by all serious students of the biological sciences.

Spencer, Edwin R. 1957

JUST WEEDS

Charles Scribner's $4.50

A good key with black and white illustrations.

## II. Living Things

### B. Classification

1. IDENTIFICATION KEYS TO THE NATURAL PLANTS AND ANIMALS OF MINNESOTA

Breckenridge, Walter J. 1944

REPTILES AND AMPHIBIANS OF MINNESOTA

University of Minnesota Press $4.00

Christensen, Clyde M. 1955

COMMON FLESHY FUNGI

Burgess $4.25

Eddy, Samuel and A. C. Hodson 1961

TAXONOMIC KEYS TO THE COMMON ANIMALS OF THE NORTH CENTRAL STATES, EXCLUSIVE OF THE PARASITIC WORMS, INSECTS AND BIRDS

Burgess $3.50

Fassett, Norman C. 1947

"A SPRING FLORA OF WISCONSIN"

University of Wisconsin Press $2.50

Gunderson, Harvey L. and James R. Beer 1953

MAMMALS OF MINNESOTA

University of Minnesota (paper) $2.00

Moyle, John B. 1964

NORTHERN NON-WOODY PLANTS: A FIELD KEY TO THE MORE COMMON FERNS AND FLOWERING PLANTS OF MINNESOTA AND ADJACENT REGIONS

Burgess $3.90

II. Living Things B-1 (continued)

Roberts, Thomas S. 1955

A MANUAL FOR THE IDENTIFICATION OF THE BIRDS OF MINNESOTA AND NEIGHBORING STATES

University of Minnesota Press $4.50

Rosendahl, Carl Otto 1955

TREES AND SHRUBS OF THE UPPER MIDWEST

University of Minnesota Press $7.00

Tryon, Rollo M., Jr. 1954

THE FERNS AND FERN ALLIES OF MINNESOTA

University of Minnesota Press $1.75

## II. Living Things

### B. Classification

2. THE OUTSTANDING NATURE BOOK SERIES, as published by:

Doubleday & Company, Inc.
Institutional Department
Garden City, L.I., New York 11531

Buchsbaum, Ralph and Lorus Milne 1960

THE LOWER ANIMALS: Living Invertebrates of the World (592)

Doubleday $12.50

Cochran, Doris M. 1961

LIVING AMPHIBIANS OF THE WORLD (597.6)

Doubleday $12.50

Ditmars, Raymond L. 1937

THE REPTILES OF NORTH AMERICA (598.1)

Doubleday $9.50

Fenton, Carroll Lane and Mildred A. Fenton 1958

THE FOSSIL BOOK (560)

Doubleday $15.00

Fenton, Carroll Lane and Mildred A. Fenton 1940

THE ROCK BOOK (552)

Doubleday $9.95

Gilliard, E. Thomas 1958

LIVING BIRDS OF THE WORLD (598.2)

Doubleday $12.50

II. Living Things B-2 (continued)

Herald, Earl S. 1961

LIVING FISHES OF THE WORLD (597)

Doubleday $12.50

Huxley, Sir Julian 1961

THE DOUBLEDAY PICTORIAL LIBRARY OF NATURE (574)

Doubleday $12.95

Kleijn, H. 1962

MUSHROOMS AND OTHER FUNGI (589)

Doubleday $11.95

Klots, Alexander B. and Elsie B. Klots 1959

LIVING INSECTS OF THE WORLD (595.7)

Doubleday $12.50

Lemmon, Robert S. 1961

WILDFLOWERS OF NORTH AMERICA IN FULL COLOR (582.13)

Doubleday $9.95

Pearson, T. Gilbert 1936

BIRDS OF AMERICA (598.2)

Doubleday $8.95

Sanderson, Ivan T. 1955

LIVING MAMMALS OF THE WORLD (599)

Doubleday $12.50

Schmidt, Karl P. and Robert P. Inger 1957

LIVING REPTILES OF THE WORLD (598.1)

Doubleday $12.50

II. Living Things

B. Classification

3. THE PETERSON FIELD GUIDE SERIES, as published by:
Houghton-Mifflin Company
1900 South Batavia Avenue
Geneva, Illinois 60134

Burt, William H. and R. P. Grossenheider 1964

A FIELD GUIDE TO THE MAMMALS, No. 5

Houghton-Mifflin Co. $4.95

Cobb, Boughton 1956

A FIELD GUIDE TO THE FERNS AND THEIR RELATED FAMILIES, No. 10

Houghton-Mifflin $4.50

Conant, Roger 1958

A FIELD GUIDE TO REPTILES AND AMPHIBIANS, No. 12

Houghton-Mifflin Co. $4.95

Klots, Alexander B. 1951

A FIELD GUIDE TO THE BUTTERFLIES, No. 4

Houghton-Mifflin Co. $4.50

Morris, Percy A. 1951

A FIELD GUIDE TO THE SHELLS OF OUR ATLANTIC AND GULF Coasts, No. 3

Houghton-Mifflin Co. $4.95

Morris, Percy A. 1952

A FIELD GUIDE TO THE SHELLS OF THE PACIFIC COAST AND HAWAII, No. 6

Houghton-Mifflin $4.50

II. Living Things B-3 (continued)

Murie, Olaus J. 1954

A FIELD GUIDE TO ANIMAL TRACKS, No. 9

Houghton-Mifflin Co. $4.95

Peterson, Roger Tory 1947

A FIELD GUIDE TO THE BIRDS (Eastern), No. 1

Houghton-Mifflin Co. $4.95

Peterson, Roger Tory 1959

A FIELD GUIDE TO BIRD SONGS (2-Record Album), No. 1R

Houghton-Mifflin Co. $10.95

Peterson, Roger Tory 1954

A FIELD GUIDE TO WESTERN BIRDS, No. 2

Houghton-Mifflin Co. $4.95

Peterson, Roger Tory 1962

A FIELD GUIDE TO WESTERN BIRD SONGS (3-Record Album), No. 2R

Houghton-Mifflin Co. $12.95

Petrides, George A. 1958

A FIELD GUIDE TO TREES AND SHRUBS, No. 11

Houghton-Mifflin Co. $4.95

Pough, Frederick H. 1953

A FIELD GUIDE TO ROCKS AND MINERALS, No. 7

Houghton-Mifflin Co. $4.95

II. Living Things B-3 (continued)

Craighead, John J., Frank C. Craighead, Jr. and Ray J. Davis 1963

A FIELD GUIDE TO ROCKY MOUNTAIN WILDFLOWERS, No. 14

Houghton-Mifflin Co. $4.95

## II. Living Things

### B. Classification

4. THE PICTURED-KEY NATURE SERIES as published by: William C. Brown Co.
Publishers
135 South Locust
Dubuque, Iowa 52003

Jaques, H. E. 1951

HOW TO KNOW THE BEETLES

Brown $3.50 (Wire Coil Binding) $4.25 (Cloth Binding)

Ehrlich, Paul R. 1961

HOW TO KNOW THE BUTTERFLIES

Brown $2.75 (Wire Coil Binding) $3.25 (Cloth Binding)

Dawson, E. Yale 1963

HOW TO KNOW THE CACTI

Brown $2.25 (Wire Coil Binding) $2.75 (Cloth Binding)

Burch, John B. 1962

HOW TO KNOW THE EASTERN LAND SNAILS

Brown $2.50 (Wire Coil Binding) $3.00 (Cloth Binding)

Jaques, H.E. 1958

HOW TO KNOW THE ECONOMIC PLANTS

Brown $2.25 (Wire Coil Binding) $2.75 (Cloth Binding)

Cuthbert, Mabel Jaques 1949

HOW TO KNOW THE FALL FLOWERS

Brown $2.25 (Wire Coil Binding) $2.75 (Cloth Binding)

II. Living Things B-4 (Continued)

Prescott, Gerald W. 1964

HOW TO KNOW THE FRESH-WATER ALGAE

Brown $3.00 (Wire Coil Binding) $3.50 (Cloth Binding)

Eddy, Samuel 1957

HOW TO KNOW THE FRESHWATER FISHES

Brown $2.75 (Wire Coil Binding) $3.25 (Cloth Binding)

Pohl, Richard W. 1953

HOW TO KNOW THE GRASSES

Brown $2.25 (Wire Coil Binding) $2.75 (Cloth Binding)

Helfer, Jaques R. 1963

HOW TO KNOW THE GRASSHOPPERS AND THEIR ALLIES

Brown $3.50 (Wire Coil Binding) $4.25 (Cloth Binding)

Chu, H. F. 1949

HOW TO KNOW THE IMMATURE INSECTS

Brown $2.50 (Wire Coil Binding) $3.00 (Cloth Binding)

Jaques, H. E. 1947

HOW TO KNOW THE INSECTS

Brown $2.25 (Wire Coil Binding) $2.75 (Cloth Binding)

Jaques, H. E. 1947

HOW TO KNOW THE LAND BIRDS

Brown $2.25 (Wire Coil Binding) $2.75 (Cloth Binding)

II. Living Things B-4 (Continued)

Jaques, H. E. 1946

LIVING THINGS - HOW TO KNOW THEM

Brown $2.25 (Wire Coil Binding) $2.75 (Cloth Binding)

Booth, Ernest S. 1961

HOW TO KNOW THE MAMMALS

Brown $2.75 (Wire Coil Binding) $3.25 (Cloth Binding)

Conrad, Henry S. 1956

HOW TO KNOW THE MOSSES AND LIVERWORTS

Brown $2.50 (Wire Coil Binding) $3.00 (Cloth Binding)

Jaques, H. E. 1948

PLANT FAMILIES - HOW TO KNOW THEM

Brown $2.25 (Wire Coil Binding) $2.75 (Cloth Binding)

Jahn, Theodore L. 1949

HOW TO KNOW THE PROTOZOA

Brown $2.75 (Wire Coil Binding) $3.25 (Cloth Binding)

Dawson, E. Yale 1956

HOW TO KNOW THE SEAWEEDS

Brown $2.25 (Wire Coil Binding) $2.75 (Cloth Binding)

Kaston, B. J. and Elizabeth Kaston 1953

HOW TO KNOW THE SPIDERS

Brown $2.50 (Wire Coil Binding) $3.00 (Cloth Binding)

II. Living Things B-4 (Continued)

Cuthbert, Mabel Jaques 1949

HOW TO KNOW THE SPRING FLOWERS

Brown $2.25 (Wire Coil Binding) $2.75 (Cloth Binding)

Jaques, H. E. 1946

HOW TO KNOW THE TREES

Brown $2.25 (Wire Coil Binding) $2.75 (Cloth Binding)

Jaques, H. E. and Roy Ollivier 1960

HOW TO KNOW THE WATER BIRDS

Brown $2.50 (Wire Coil Binding) $3.00 (Cloth Binding)

Jaques, H. E. 1959

HOW TO KNOW THE WEEDS

Brown $2.75 (Wire Coil Binding) $3.25 (Cloth Binding)

Baerg, Harry J. 1955

HOW TO KNOW THE WESTERN TREES

Brown $2.25 (Wire Coil Binding) $2.75 (Cloth Binding)

II. Living Things

B. Classification

5. THE PUTNAM'S NATURE FIELD BOOKS as published by: G. P. Putnam's & Sons
200 Madison Avenue
New York, N.Y. 10016

| | |
|---|---|
| Alexander, W. B. 1963 | |
| BIRDS OF THE OCEAN | |
| Putnam's & Sons | $3.71 |
| Armstrong, Margaret 1915 | |
| FIELD BOOK OF WESTERN WILD FLOWERS | |
| Putnam's & Sons | $3.75 |
| Breder, Charles M., Jr. 1948 | |
| MARINE FISHES OF THE ATLANTIC COAST | |
| Putnam's & Sons | $3.75 |
| Durand, Herbert 1948 | |
| FIELD BOOK OF COMMON FERNS | |
| Putnam's & Sons | $2.96 |
| Hausman, Leon A. 1946 | |
| FIELD BOOK OF EASTERN BIRDS | |
| Putnam's & Sons | $3.71 |
| Hillcourt, William 1961 | |
| FIELD BOOK OF NATURE ACTIVITIES | |
| Putnam's & Sons | $3.71 |

## II. Living Things B-5 (Continued)

Loomis, Frederick B. 1948

COMMON ROCKS AND MINERALS

Putnam''s & Sons $2.96

Lutz, Frank E. 1948

FIELD BOOK OF INSECTS

Putnam's & Sons $3.38

Mathews, F. Schuyler 1915

AMERICAN TREES AND SHRUBS

Putnam's & Sons $3.38

Miner, Roy Waldo 1950

FIELD BOOK OF SEASHORE LIFE

Putnam's & Sons $8.00

Morgan, Ann 1930

FIELD BOOK OF PONDS AND STREAMS

Putnam's & Sons $3.75

Morgan, Ann 1939

FIELD BOOK OF ANIMALS IN WINTER

Putnam's & Sons $3.75

Olcott, W. T. and R. and M. Mayall 1954

FIELD BOOK OF THE SKIES

Putnam's & Sons $3.75

## II. Living Things B-5 (Continued)

Rickett, Harold William 1963

NEW FIELD BOOK OF AMERICAN WILD FLOWERS

Putnam's & Sons $3.71

Schmidt, Karl P. and D. Dwight Davis 1941

FIELD BOOK OF SNAKES

Putnam's & Sons $2.96

Thomas, William S. 1948

FIELD BOOK OF COMMON MUSHROOMS

Putnam's & Sons $3.75

Verell, A. Hyatt 1950

SHELL COLLECTOR'S HANDBOOK

Putnam's & Sons $3.71

Klotz, Elsie B. 1966

NEW FIELD BOOK OF FRESHWATER LIFE

Putnam's & Sons $4.95

II. Living Things

C. Ecology

Bates, Marston 1961

THE FOREST AND THE SEA: A LOOK AT THE ECONOMY OF NATURE AND THE ECOLOGY OF MAN

| | |
|---|---|
| Random House | $3.95 |
| (Paperback-Mentor) | $ .50 |

An examination of the life of forests, lakes, grasslands, deserts, coral reefs and the open seas, not for the purpose of describing life in nature, per se, but as an attempt to demonstrate how man must learn to live harmoniously and in cooperation with the other occupants of his own biological environment.

Bruce, Wallace and Adrian 1964

ADAPTATION

| | |
|---|---|
| Prentice-Hall | $3.95 |
| (Paper) | $1.75 |

Contains a new chapter on the adaptive nature of communication. Traces the phenomenon of adaptation of living things to their changing environments and describes the evolution of natural population. Imparts to the student an understanding of how adaptation actually occurs, with a focus on theories of evolution and biological adaptation.

Buchsbaum, Ralph and Mildred Buchsbaum 1957

BASIC ECOLOGY

| | |
|---|---|
| Boxwood Press | $3.50 |
| (Paper) | $2.35 |

Living plants and animals cannot be studied thoroughly without a consideration of their natural environment, and the various forces, interactions and associations inherent therein. Plans for the utilization, conservation, and restoration of natural living resources must be based upon a consideration of the ecological complex. Here is a good, simplified presentation.

## II. Living Things - C (Continued)

Carson, Rachel L. 1962

SILENT SPRING

Houghton-Mifflin Co. $5.00

The author examines the poisonous effects of man's widespread use of pesticides in an alarming but significant book recommended for mature readers.

Comstock, Anna B. 1939

HANDBOOK OF NATURE-STUDY

Cornell University Press $6.75

Although designed primarily as a teaching aid, this nature guide presents its information in a way which makes it interesting to any amateur naturalist.

Hanrahan, James S. and David Bushnell 1960

SPACE BIOLOGY: THE HUMAN FACTORS IN SPACE FLIGHT

Basic Books, Inc. $6.75

A well-written survey of the problems of present and future space flights, such as transporting sufficient food for the astronauts.

Hillcourt, William 1950

FIELD BOOK OF NATURE ACTIVITIES

Putnam's & Sons $3.95

Clear directions for hundreds of absorbing and instructive projects for nature lovers. The many hints and tips on woodlore will give the reader a new insight into the life of the forest.

## II. Living Things - C (Continued)

Kendeigh, S. Charles 1961

ANIMAL ECOLOGY

Prentice-Hall $11.95

Text covers the study of living animals in their natural environments, how they interrelate within biotic communities, and their geographical distribution.

Milne, Lorus J. and Margery J. Milne 1961

A MULTITUDE OF LIVING THINGS

Apollo $1.95

Discusses the small creatures found in almost any woods or along nearly any shore.

Morgan, Ann H. 1930

FIELD BOOK OF PONDS AND STREAMS

Putnam's & Sons $5.00

Discusses the communities of life in ponds and streams, their habits, and where to collect them.

Oosting, Henry J. 1956

THE STUDY OF PLANT COMMUNITIES: AN INTRODUCTION TO PLANT ECOLOGY

Freeman $6.50

The vegetation of North America serves as the primary source of illustrative material for this introduction to the ecology of plant communities. References are primarily to American literature.

## II. Living Things - C (Continued)

Osborn, Fairfield 1948

OUR PLUNDERED PLANET

| | |
|---|---|
| Little | $3.95 |
| (Paper) | $1.95 |

A strong warning against the abuse of nature by man which threatens the future of the human race.

Peterson, Alvah 1956

FISHING WITH NATURAL INSECTS: A HANDBOOK OF INSECTS FOR BAIT USE

| | |
|---|---|
| Alvah Peterson<br>2039 Collingswood Road<br>Columbus 21, Ohio | $6.00 |

Avid fisherman will find in this book the native insects which may be used as bait and how to use them.

Storer, John H. 1953

THE WEB OF LIFE

| | |
|---|---|
| Devin-Adair Co. | $3.00 |

Sound conclusions on conservation are drawn from thie study of ecology.

## II. Living Things

### D. Plant and Animal Economics

Allen, Durward L. 1954

OUR WILDLIFE LEGACY

| | |
|---|---|
| Funk & Wagnalls Co. | $5.00 |

Describes the American resources of birds, animals and fish, and outlines the principles of wildlife conservation.

American Meat Institute Foundation 1960

THE SCIENCE OF MEAT AND MEAT PRODUCTS

| | |
|---|---|
| Freeman | $9.60 |

Presents current scientific knowledge of meat structure, chemistry, microbiology and nutritional values and describes the science of meat processing and preservation.

Brown, Harrison 1956

THE CHALLENGE OF MAN'S FUTURE

| | |
|---|---|
| Compass | $3.75 |
| Viking (paperback) | $1.65 |

The vital problem of population, food supply and the changes that will take place in the years to come.

Christensen, Clyde M. 1961

THE MOLDS AND MAN: AN INTRODUCTION TO THE FUNGI

| | |
|---|---|
| University of Minnesota Press | $5.50 |
| (Paper) | $1.75 |

Presents accurate factual information regarding the nature of fungi, in a delightfully readable style. This third edition has added chapters on classification and toxicity.

II. Living Things - D (Continued)

Coombs, Charles I. 1960

HIGH TIMBER: THE STORY OF AMERICAN FORESTRY

World Publishing Co. $4.95

A lucid readable account of forestry. In telling of the misuse of timber in the past, tracing the history of the U.S. Forest Service, and describing modern logging methods and wood processing the author shows how forestry works to make the wisest possible use of forests. Discusses forests in relation to wildlife conservation and to recreation, explains the menace and control of fire, pests and disease and forestry as a vocation.

de Ong, E. R. 1960

CHEMICAL AND NATURAL CONTROL OF PESTS

Reinhold $7.50

To assist research worker, instructor, farmer and manufacturer in evaluating the most effective combination methods of pest control. Stressing the importance of natural control of pests, author shows that nature, unaided by chemical supplements, cannot provide the degree of extermination necessary to maintain our high standards of production.

Fitzpatrick, Frederick L. 1963

OUR ANIMAL RESOURCES

Holt, Rinehart and Winston $2.50

Animals that are important to man as sources of food, clothing, drugs, oils, and other miscellaneous products are briefly described and classified, their economic importance discussed, and the need for their conservation stressed. Will be most useful as a catalog of animals and animal products in connection with the study of geography.

## II. Living Things - D (Continued)

Hambleton, Jack 1960

FIRE IN THE VALLEY

Longmans $3.75

Tells authentic story of how a forest fire begins, how it travels, the damage it causes, based on fire in Ontario, Canada, which covered nearly 12,000 acres in a single afternoon.

Hubbard, Alice Harvey 1960

THIS LAND OF OURS: COMMUNITY AND CONSERVATION PROJECTS FOR CITIZENS

Macmillan $4.95

Suggests and describes actual conservation projects for civic-minded groups.

Klingman, Glenn C. and Lyman J. Noordhoff 1961

WEED CONTROL: AS A SCIENCE

Wiley $8.50

Up-to-date textbook, written in readable form, presents a thorough review of the chemistry of various herbicides, their physiological effects, and applied phases of weed control

Moore, Alma Chestnut 1960

THE GRASSES: EARTH'S GREEN WEALTH

Macmillan $5.00

Deals with the origins, cultivation, botanical characteristics and uses of the entire grass family, including the grains.

## II. Living Things - D (Continued)

Schery, Robert W. 1952

PLANTS FOR MAN

Prentice-Hall, Inc. $8.75

The absorbing story of man's dependence on plants and of the products derived from them; a sound, popular book on economic botany.

Shurtleff, Malcolm C. 1966

HOW TO CONTROL PLANT DISEASES IN HOME AND GARDEN

Iowa State University Press $8.50

Provides identification and control measures for more than 4,600 diseases of 2,200 species of house and yard plants.

Sollers. Allan A. 1963

OURS IS THE EARTH

Holt, Rinehart and Winston $2.50

A discussion of the importance of conserving soil, water, forests, rangelands, wildlife, and minerals in a world of rapidly increasing population. Author emphasizes interdependence of these natural resources. Explanation of conservation problems and evaluation of current practices useful.

Stefferud, Alfred 1959

FOOD: THE YEARBOOK OF AGRICULTURE

U.S. Department of Agriculture $2.25
(Govt. Printing Office)

Authoritative compendium of knowledge about nutrients, health and food needs, quality, costs, preparation and trends in food processing and consumption.

II. Living Things - D (Continued)

Talley, Naomi 1961

IMPORTED INSECTS

| | |
|---|---|
| Dial Press | $2.50 |

Tells young people how entomologists search for the natural enemies of insect pests to be imported as "biological controls."

## II. Living Things

### E. Human Body

Atkinson, D. T. 1962

MAGIC, MYTH AND MEDICINE

Fawcett World Library (paper) $0.50

The fascinating story of medicine from its strange, terrifying beginnings in pagan ritual to the science it is today.

Bremner, Maurice David K. 1954

THE STORY OF DENTISTRY

Dental Items of Interest Publishing Co. $7.50

A record of dental progress through the ages, from primitive man's rude attempts to extract a tooth to modern oral surgery.

Burn, Harold 1962

DRUGS, MEDICINES AND MAN

Scribner $4.50

About the action of drugs on the human body written by a professor of pharmacology for the general reader.

Burnet, F. M. 1962

THE INTEGRITY OF THE BODY: A Discussion of Modern Immunological Ideas

Harvard University Press $4.75
Atheneum (1966) $1.75

Nobelist (1960) outlines the facts and latest theories of immunity in language understandable to non-specialists.

II. Living Things - E (Continued)

Burnet, Sir Macfarlane 1953

NATURAL HISTORY OF INFECTIOUS DISEASE

Cambridge University Press $4.50

A book on the nature, causes, action and combating of infectious disease; can be read and understood by any interested person.

Cameron, Charles S. 1956

THE TRUTH ABOUT CANCER

Prentice-Hall, Inc. $4.95

With the proper information in the hands of the layman, the cancer cure rate can be doubled. This volume provides that information clearly and with authority.

Chandler, Asa C. 1955

INTRODUCTION TO PARASITOLOGY

John Wiley & Sons, Inc. $8.50

Comprehensive coverage of this field, with emphasis on parasites of man. Excellent illustrations.

Cooley, Donald G. 1963

THE SCIENCE BOOK OF MODERN MEDICINE

Cardinal (paperback) $0.50

Relates today's revolution in biology to advances in knowledge of the chemical processes of life to newer concepts of some of the fundamental mechanisms of health and disease, and to treatments currently employed by the medical professions, with some intimations of those that loom in the near future.

## II. Living Things - E (Continued)

Darby, William J., et al 1961

FOOD AND SCIENCE: Today and Tomorrow

Public Affairs Committee, Pamphlet No. 320
381 Park Avenue South, New York, $0.25
N.Y. 10016

Discusses the functions of food additives and their safe use.

De Kruif, Paul 1957

A MAN AGAINST INSANITY

Harcourt, Brace & World $3.95

A fascinating biography of Dr. John T. Ferguson and his work with tranquilizers in the treatment of mental illness.

De Kruif, Paul 1932

MEN AGAINST DEATH

Harcourt, Brace & World $3.75

The most interesting...stories of the medical discoveries of the present century have been gathered together.

De Kruif, Paul 1959

MICROBE HUNTERS

| | |
|---|---|
| Harcourt, Brace & World | $2.40 |
| Cardinal (paper) | $0.50 |
| Washington Square | $0.50 |

A classic in modern scientific writing, describing the work of the great pioneers of microbiology.

Dubos, Rene and Jean Dubos 1952

THE WHITE PLAGUE: TUBERCULOSIS, MAN AND SOCIETY

Little, Brown & Co. $5.00

The history and causes of tuberculosis and its relation to social conditions are related in a fascinating manner.

II. Living Things - E (Continued)

Eberson, Frederick 1948

MICROBES MILITANT: A CHALLENGE TO MAN

Ronald Press $5.00

An intelligently written survey of the classic developments in pathogenic microbiology. Written primarily for the layman but detailed enough to provide interesting reading for the student.

Frohse, Franz, et al 1961

ATLAS OF HUMAN ANATOMY

Barnes & Noble $2.95

Describes the human body through charts, standard guidebook for nurses, doctors, students and general reader.

Gofman, John W. 1958

WHAT WE DO KNOW ABOUT HEART ATTACKS

Putnam $3.50

The author clearly and objectively presents the latest facts concerning heart malfunctions.

Hanrahan, James Stephen and David Bushnell 1960

SPACE BIOLOGY: THE HUMAN FACTORS IN SPACE FLIGHT

Basic Books $6.00

Comprehensive survey of research findings as man explores the physical and psychological forces beyond the life-supporting atmosphere of his native planet.

Hirschfeld, Herman 1960

THE WHOLE TRUTH ABOUT ALLERGY

Arco Publishing Co, Inc. $0.50

Doctor explains what allergy is and what to expect from treatment.

## II. Living Things - E (Continued)

Keller, Ronald 1961

HUMAN ANATOMY ATLAS

| | |
|---|---|
| Hammond | $1.00 |

Depicts component parts of both the female and male anatomy. Twenty full color illustrations which have die cut margins which, when removed, enable the reader to see the correct relationships of the various organs and framework of the torso.

Li, Ching Chun 1961

HUMAN GENETICS: PRINCIPLES AND METHODS

| | |
|---|---|
| McGraw-Hill | $9.50 |

The author presents in a clear, concise manner the fundamental principles of human genetics. The entire text is devoted to discussion of human families and human populations, and particular hereditary diseases or traits are used only as examples to illustrate very general underlying principles.

Marvin, H. M. 1960

YOUR HEART: A HANDBOOK FOR LAYMEN

| | |
|---|---|
| Doubleday & Company | $4.50 |

An informative, clearly written handbook by a heart specialist explains in simple terms the nature of heart diseases and disturbances, their effect on the heart's ability to perform its function, and types of medical and surgical treatment now available. Each disease and disorder is treated individually; the book also contains material on such topics as the heart in pregnancy, obesity, effect of smoking on the heart, and the doctor-patient relationship.

Mason, A. Stuart 1960

HEALTH AND HORMONES

| | |
|---|---|
| Penguin (Paperback) | $1.65 |

New and fascinating aspects of human physiology are opened up for the reader by this author as he gives us a simple, accurate and very amusing survey of the endocrine system.

II. Living Things - E (Continued)

Morrison, Thomas F., Frederick D. Cornett and J. Edward Tether 1963

HUMAN PHYSIOLOGY

Holt, Rinehart & Winston $6.32

A High School textbook on general human physiology, written specifically for an advanced, elective course in Grades 11 and 12.

Penrose, L. S. 1963

OUTLINE OF HUMAN GENETICS

Wiley & Sons $3.50

An introduction to the facts of human genetics for the non-specialist. Topics covered include single gene effects, association and linkage, interplay of environment and eugenics and dysgenics.

Riedman, Sarah R. 1960

SHOTS WITHOUT GUNS: THE STORY OF VACCINATION

Rand McNally $4.50

In an unusual way the author tells of the lives, adventures, hopes, disappointments, fumblings, mistakes and the life-saving successes of the scientists who conquered infectious diseases.

Rostand, Jean 1957

HUMAN HEREDITY

Philosophical Library $4.75

Basic and complex facts of human heredity, written by scientist for the layman.

## II. Living Things - E (Continued)

Swartz, Harry 1960

ALLERGY: WHAT IT IS AND WHAT TO DO ABOUT IT

| | |
|---|---|
| Ungar | $3.95 |

Allergist discusses all aspects of allergy and latest developments in therapy for general reader.

Taylor, A. B. and Frederick Sargent, II 1961

ELEMENTARY HUMAN PHYSIOLOGY: LABORATORY AND DEMONSTRATION MANUAL

| | |
|---|---|
| Burgess | $2.75 |

This laboratory text introduces the beginning college student to the way science "finds out". Experimental physiology gives many valuable understandings.

Turner, Donnell C. 1960

GENERAL ENDOCRINOLOGY

| | |
|---|---|
| Saunders | $9.50 |

Completely rewritten and updated; presents endocrinology as a basic science rather than a clinical specialty, with emphasis on experimental aspects.

Weart, Edith Lucie 1961

THE STORY OF YOUR BRAIN AND NERVES

| | |
|---|---|
| Coward-McCann | $3.00 |

Clear and simple description of the intricate communications system of our bodies.

## II. Living Things - E (Continued)

Weidel, Wolfhard 1960

VIRUS

University of Michigan Press $1.95

Tells what viruses are, how they behave, and explains the crucial place of viruses in solving the puzzle of life processes.

Welch, Henry and Marti-Ibanez, Felix 1960

THE ANTIBIOTIC SAGA

Medical Encyclopedia $3.00

The story of antibiotics from past to present, with the human story of the physicians and investigators who made medical history.

Zim, Herbert S. 1959

YOUR HEART AND HOW IT WORKS

Morrow $2.50

The function, structure and diseases of the heart are explained with excellent drawings and diagrams.

Zinsser, Hans 1935

RATS, LICE AND HISTORY

Little $6.00
Bantam (Paper - 1960) $0.75

An intriguing biography of typhus and its effects on the shaping of history. The role played by lice and rats as carriers is emphasized.

## II. Living Things

### F. Aesthetic Values

Belvianes, Marcel 1957

EXOTIC PLANTS OF THE WORLD

Doubleday & Company $4.95

Fascinating work, illustrating and commenting upon the beauties and wonders of the plant kingdom.

Better Homes and Gardens, Editors of 1959

HOUSEPLANTS: FOR THE INDOOR GARDENER

Meredith Publishing Company $2.95

To all who delight in the daily presence of green and growing things. In it are advice and information for both novice and experienced gardeners. Shows how to select the right plants, how to display them and how to keep them growing.

Brown, Emily L. 1961

TRAINED AND SCULPTURED PLANTS: A HANDBOOK

Brooklyn Botanic Garden $1.00

Guide to the trimming and training of trees, shrubs and vines.

Carleton, R. Milton 1957

NEW WAY TO KILL WEEDS IN YOUR LAWN AND GARDEN

Arco $2.50

Written for the average homeowner with crabgrass and other common weeds in his lawn. Explains methods and materials to eliminate them. A special section is included on poison ivy.

Chrystie, Frances N. 1964

PETS

Little $4.00

A complete handbook on the care, understanding, and appreciation of all kinds of animal pets.

II. Living Things - F (Continued)

Dowling, Herndon G., et al 1960

THE CARE OF PET TURTLES

U.S. Zoological Society $0.25

Practical directions for maintaining these pets. Feeding, health problems and general care of different species of turtles are discussed.

Gardiner, G. F. 1961

MODERN INDOOR GARDENING: INCLUDING WINDOW BOXES

Macmillan $4.50

Gives details on care of plants suitable for indoor cultivation

Ley, Willy 1959

EXOTIC ZOOLOGY

Viking $4.95

A wonderful omnibus of Willy Ley's best writing as a "romantic naturalist" gathered from his three famous books of scientific mysteries--rearranged, expanded, and brought up to date with accounts of some fascinating recent discoveries.

Moore, Clifford B. 1954

THE BOOK OF WILD PETS

Branford $6.50

A discussion on the care and feeding of our native wildlife in captivity, together with notes on their identification and life habits.

## II. Living Things - F (Continued)

Muller-Idzerda, A. C. 1959

100 INDOOR PLANTS: THEIR CARE AND CULTIVATION

Emerson $2.95

The 100 plants included in this little guide are a good representative group, and the photographs that accompany their description and advice as to their care are well chosen. Simple and accurate. Very useful for the amateur in helping plan for plants in his home

Northen, Henry and Rebecca Northen 1954

THE SECRET OF THE GREEN THUMB

Ronald Press $6.00

Every gardener with a genuine love of plants will develop real understandings of what goes on inside of plants when he reads this book. In simple nontechnical language with striking illustrations the reader is shown how plants are put together and how they react to their environment. Practical hints of plant breeding, plant classification, insect pests and plant diseases are made by the authors.

Schery, Robert W. 1961

THE LAWN BOOK

Macmillan $5.95

Covers each aspect of planning, planting and maintaining lawn grasses suitable to any U. S. climate.

Slate, George M. 1961

FRUITS IN THE HOME GARDEN: A HANDBOOK

Brooklyn Botanic Garden $1.00

Leading authorities give advice to the amateur gardener on all phases of fruit culture.

II. Living Things - F (Continued)

Strohm, John 1961

THE GOLDEN GARDEN GUIDE: A PRACTICAL HANDBOOK OF GARDENING AND OUTDOOR LIVING

| | |
|---|---|
| Golden Press | $1.00 |

Full of useful, clearly presented gardening hints for every season and region in the United States.

William, Joseph F. 1960

SUNSET LAWN AND GROUND COVER BOOK

| | |
|---|---|
| Lane Publishing Company | $1.75 |

Evaluation chart of cool-season grasses and vital statistics charts on 100 ground covers.

Ries, Victor H. 1961

HANDBOOK ON ROCK GARDENS

| | |
|---|---|
| Brooklyn Botanic Garden | $1.00 |

Expert articles on rock garden design, rocks, soil and plants for various regions, on propagation and pest control. Generously illustrated.

## II. Living Things

### Archaeology

Childe, V. Gordon 1951

MAN MAKES HIMSELF

| | |
|---|---|
| Mentor | $0.60 |

A well-written survey of civilization's early history

Howells, William 1954

BACK OF HISTORY

| | |
|---|---|
| Doubleday | $5.00 |

Traces human origins from the days of the old hunters into the times of the Greek and Roman civilizations.

## II. Living Things

### Anthropology

Beals, Ralph L. and Harry Hoijer 1959

AN INTRODUCTION TO ANTHROPOLOGY

Macmillan $6.90

An excellent introduction to both physical and cultural anthropology which is readily understood by the layman. A thorough presentation of the origin development and differentiation of man as a biological organism. The concept of culture, its structure and development in all its diversities is explained.

Berrill, Norman J. 1961

MAN'S EMERGING MIND

Apollo $1.95
Fawcett (Paperback) $0.60

Clark, W. E. LeGros 1955

THE FOSSIL EVIDENCE FOR HUMAN EVOLUTION

University of Chicago Press $6.00

The important fossil discoveries presented for the advanced student and specialist in the field.

Coon, Carleton S. 1954

THE STORY OF MAN

Knopf $6.75

Includes a brief description of human evolution, the development of medicine and technology, and the history of several cultures.

II. Living Things - Anthropology (Continued)

Kroeber, Alfred L. 1948

ANTHROPOLOGY

| | |
|---|---|
| Harcourt, Brace & World | $9.75 |

A complete and authoritative examination of race, language culture, psychology and pre-history.

von Koenigswald, G. H. R. 1962

THE EVOLUTION OF MAN

| | |
|---|---|
| University of Michigan Press | $5.00 |
| (Paperback) | $1.95 |

Traces the link between men, the Primates, and the fossil anthropoid apes in the light of paleontological discoveries of the last century. Primarily for college students and the lay reader with background knowledge of the subject.

AN IDEA

## LOOKING FOR AN IDEA

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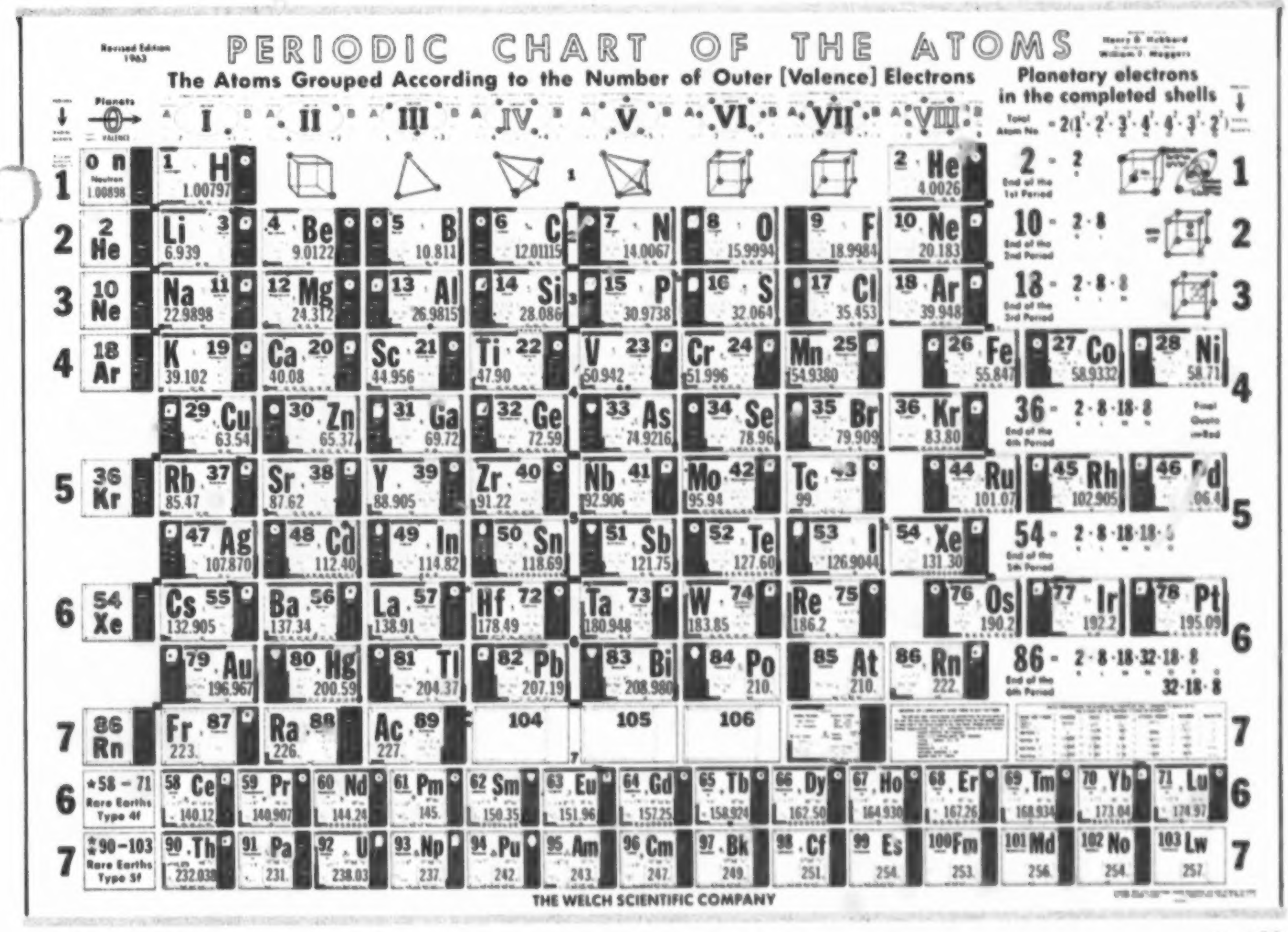
# LOOKING FOR AN IDEA?

There are many effective instructional ideas used by every good biology teacher. Included materials are for your perusal and evaluation. There are other activities and variations of these activities that you may wish to use. The books in the Methods and/or Techniques section of the references may be of value.

If you have ideas which you have found effective in your teaching, send them to the Biology Supplement Committee, c/o Science Department, Board of Education Administration Building.



Revised Edition 1963

PERIODIC CHART OF THE ATOMS

Henry D. Hubbard
William F. Meggers

The Atoms Grouped According to the Number of Outer [Valence] Electrons

Planetary electrons in the completed shells

| | | I | II | III | IV | V | VI | VII | VIII | VIII | VIII | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 n 1.00898 Neutron | 1 H 1.00797 | | | | | | | 2 He 4.0026 | | | 2 - 2 End of the 1st Period |
| 2 | 2 He | 3 Li 6.939 | 4 Be 9.0122 | 5 B 10.811 | 6 C 12.01115 | 7 N 14.0067 | 8 O 15.9994 | 9 F 18.9984 | 10 Ne 20.183 | | | 10 - 2·8 End of the 2nd Period |
| 3 | 10 Ne | 11 Na 22.9898 | 12 Mg 24.312 | 13 Al 26.9815 | 14 Si 28.086 | 15 P 30.9738 | 16 S 32.064 | 17 Cl 35.453 | 18 Ar 39.948 | | | 18 - 2·8·8 End of the 3rd Period |
| 4 | 18 Ar | 19 K 39.102 | 20 Ca 40.08 | 21 Sc 44.956 | 22 Ti 47.90 | 23 V 50.942 | 24 Cr 51.996 | 25 Mn 54.9380 | 26 Fe 55.847 | 27 Co 58.9332 | 28 Ni 58.71 | |
| | | 29 Cu 63.54 | 30 Zn 65.37 | 31 Ga 69.72 | 32 Ge 72.59 | 33 As 74.9216 | 34 Se 78.96 | 35 Br 79.909 | 36 Kr 83.80 | | | 36 - 2·8·18·8 End of the 4th Period |
| 5 | 36 Kr | 37 Rb 85.47 | 38 Sr 87.62 | 39 Y 88.905 | 40 Zr 91.22 | 41 Nb 92.906 | 42 Mo 95.94 | 43 Tc 99. | 44 Ru 101.07 | 45 Rh 102.905 | 46 Pd 106.4 | |
| | | 47 Ag 107.870 | 48 Cd 112.40 | 49 In 114.82 | 50 Sn 118.69 | 51 Sb 121.75 | 52 Te 127.60 | 53 I 126.9044 | 54 Xe 131.30 | | | 54 - 2·8·18·18·8 End of the 5th Period |
| 6 | 54 Xe | 55 Cs 132.905 | 56 Ba 137.34 | 57 La 138.91 | 72 Hf 178.49 | 73 Ta 180.948 | 74 W 183.85 | 75 Re 186.2 | 76 Os 190.2 | 77 Ir 192.2 | 78 Pt 195.09 | |
| | | 79 Au 196.967 | 80 Hg 200.59 | 81 Tl 204.37 | 82 Pb 207.19 | 83 Bi 208.980 | 84 Po 210. | 85 At 210. | 86 Rn 222. | | | 86 - 2·8·18·32·18·8 End of the 6th Period |
| 7 | 86 Rn | 87 Fr 223. | 88 Ra 226. | 89 Ac 227. | 104 | 105 | 106 | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | *58 – 71 Rare Earths Type 4f | 58 Ce 140.12 | 59 Pr 140.907 | 60 Nd 144.24 | 61 Pm 145. | 62 Sm 150.35 | 63 Eu 151.96 | 64 Gd 157.25 | 65 Tb 158.924 | 66 Dy 162.50 | 67 Ho 164.930 | 68 Er 167.26 | 69 Tm 168.934 | 70 Yb 173.04 | 71 Lu 174.97 |
| 7 | *90–103 Rare Earths Type 5f | 90 Th 232.038 | 91 Pa 231. | 92 U 238.03 | 93 Np 237. | 94 Pu 242. | 95 Am 243. | 96 Cm 247. | 97 Bk 249. | 98 Cf 251. | 99 Es 254. | 100 Fm 253. | 101 Md 256. | 102 No 254. | 103 Lw 257. |

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No. 4854

## WELCH VEST-POCKET CHART OF THE ATOMS

This is a small reproduction of the Hubbard Chart of the Atoms, revised in 1963 by William F. Meggers of the United States Bureau of Standards. This chart, or an earlier edition, hangs in almost every advanced chemistry or physics laboratory in all civilized countries of the world.

| | | |
|---|---|---|
| **No. 4854.** | Chart of the Atoms, 1963 Edition, 42 x 58 inches, lithographed in 6 colors. Complete with key. | Each, $ 7.50 |
| **No. 4854A.** | Chart of the Atoms, 1963 Edition, 42 x 58 inches, in spring-roller case. Complete with key. | Each, $17.50 |
| **No. 4858.** | Key to the Chart of the Atoms. 48 pages of atomic data, with a center spread, black and white chart 9½ x 13½ inches. | Each, $ 1.00 |

The Welch Scientific Company, 7300 N. Linder Avenue, Skokie, Illinois 60076

# THE WELCH VEST-POCKET CHART OF THE ATOMS

Density @ 20° C

Atomic weights based on $C^{12} = 12$

| At. No. | Name of Element | Sym. | Atomic Weight | Chem. Valence | Melting Point °C | Density g/cm³ |
|---|---|---|---|---|---|---|
| 89 | Actinium | Ac | [227.] | 3 | 1050. | |
| 13 | Aluminum | Al | 26.9815 | 3 | 660.1 | 2.699 |
| 95 | Americium | Am | [243.] | 3,4,5,6 | | 11.7 |
| 51 | Antimony | Sb | 121.75 | 3,5 | 630.5 | 6.62 |
| 18 | Argon | Ar | 39.948 | 0 | −189.4 | .001626 |
| 33 | Arsenic | As | 74.9216 | ± 3,5 | 817@28 AT. | 5.72 |
| 85 | Astatine | At | [210.] | | | |
| 56 | Barium | Ba | 137.34 | 2 | 714. | 3.5 |
| 97 | Berkelium | Bk | [249.] | 3,4 | | |
| 4 | Beryllium | Be | 9.0122 | 2 | 1277. | 1.848 |
| 83 | Bismuth | Bi | 208.980 | 3,5 | 271.3 | 9.80 |
| 5 | Boron | B | 10.811 | 3 | 2030. | 2.34 |
| 35 | Bromine | Br | 79.909 | ± 1,5 | − 7.2 | 3.12 |
| 48 | Cadmium | Cd | 112.40 | 2 | 320.9 | 8.65 |
| 20 | Calcium | Ca | 40.08 | 2 | 838. | 1.55 |
| 98 | Californium | Cf | [251.] | 3 | | |
| 6 | Carbon | C | 12.01115 | ± 4,2 | 3727. | 2.25 |
| 58 | Cerium | Ce | 140.12 | 3,4 | 804. | 6.768 |
| 55 | Cesium | Cs | 132.905 | 1 | 28.7 | 1.9 |
| 17 | Chlorine | Cl | 35.453 | ±1,5,7 | −100.99 | .003214 |
| 24 | Chromium | Cr | 51.996 | 2,3,6 | 1875. | 7.19 |
| 27 | Cobalt | Co | 58.9332 | 3,2 | 1495. | 8.85 |
| 29 | Copper | Cu | 63.54 | 1,2 | 1083.0 | 8.96 |
| 96 | Curium | Cm | [247.] | 3 | | |
| 66 | Dysprosium | Dy | 162.50 | 3 | 1407. | 8.55 |
| 99 | Einsteinium | Es | [254.] | | | |
| 68 | Erbium | Er | 167.26 | 3 | 1497. | 9.15 |
| 63 | Europium | Eu | 151.96 | 2,3 | 826. | 5.245 |
| 100 | Fermium | Fm | [253.] | | | |
| 9 | Fluorine | F | 18.9984 | − 1 | −219.6 | 1.14 |
| 87 | Francium | Fr | [223.] | 1 | (27) | |
| 64 | Gadolinium | Gd | 157.25 | 3 | 1312. | 7.86 |
| 31 | Gallium | Ga | 69.72 | 3 | 29.78 | 5.907 |
| 32 | Germanium | Ge | 72.59 | 4 | 937.4 | 5.323 |
| 79 | Gold | Au | 196.967 | 1,3 | 1063. | 19.32 |
| 72 | Hafnium | Hf | 178.49 | 4 | 2222. | 13.09 |
| 2 | Helium | He | 4.0026 | 0 | −269.7 | .0001785 |
| 67 | Holmium | Ho | 164.930 | 3 | 1461. | 8.79 |
| 1 | Hydrogen | H | 1.00797 | 1 | −259.19 | .00008375 |
| 49 | Indium | In | 114.82 | 3 | 156.2 | 7.31 |
| 53 | Iodine | I | 126.9044 | −1,5,7 | 113.7 | 4.94 |
| 77 | Iridium | Ir | 192.2 | 3,4,6 | 2454. | 22.5 |
| 26 | Iron | Fe | 55.847 | 2,3 | 1536.5 | 7.87 |
| 36 | Krypton | Kr | 83.80 | 0 | −157.3 | .003743 |
| 57 | Lanthanum | La | 138.91 | 3 | 920. | 6.189 |
| 103 | Lawrencium | Lw | [257.] | | | |
| 82 | Lead | Pb | 207.19 | 2,4 | 327.42 | 11.36 |
| 3 | Lithium | Li | 6.939 | 1 | 180.54 | 0.534 |
| 71 | Lutetium | Lu | 174.97 | 3 | 1652. | 9.849 |
| 12 | Magnesium | Mg | 24.312 | 2 | 650. | 1.74 |
| 25 | Manganese | Mn | 54.9380 | 2,3,4,6,7 | 1245. | 7.43 |
| 101 | Mendelevium | Md | [256.] | | | |

(FOLD HERE)

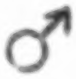
| At. No. | Name of Element | Sym. | Atomic Weight | Chem. Valence | Melting Point °C | Density g/cm³ |
|---|---|---|---|---|---|---|
| 80 | Mercury | Hg | 200.59 | 1,2 | − 38.36 | 13.55 |
| 42 | Molybdenum | Mo | 95.94 | 3,5,6 | 2610. | 10.22 |
| 60 | Neodymium | Nd | 144.24 | 3 | 1019. | 7.00 |
| 10 | Neon | Ne | 20.183 | 0 | −248.6 | .0008999 |
| 93 | Neptunium | Np | [237.] | 3,4,5,6 | 637. | 19.5 |
| 28 | Nickel | Ni | 58.71 | 2,3 | 1453. | 8.[illegible] |
| 41 | Niobium | Nb | 92.906 | 3,5 | 2468. | 8.5[illegible] |
| 7 | Nitrogen | N | 14.0067 | 2,−3,5 | −209.97 | .001250 |
| 102 | Nobelium | No | [254.] | | | |
| 76 | Osmium | Os | 190.2 | 4,6,8 | 2700. | 22.57 |
| 8 | Oxygen | O | 15.9994 | − 2 | −218.83 | .001429 |
| 46 | Palladium | Pd | 106.4 | 2,4 | 1552. | 12.02 |
| 15 | Phospherus | P | 30.9738 | ± 3,5 | 44.25 | 1.83 |
| 78 | Platinum | Pt | 195.09 | 2,4 | 1769. | 21.45 |
| 94 | Plutonium | Pu | [242.] | 3,4,5,6 | 640. | 19.0 |
| 84 | Polonium | Po | [210.] | 2,4 | 254. | (9.24) |
| 19 | Potassium | K | 39.102 | 1 | 63.7 | 0.86 |
| 59 | Praseodymium | Pr | 140.907 | 3 | 919. | 6.769 |
| 61 | Promethium | Pm | [145.] | 3 | (1027.) | |
| 91 | Protactinium | Pa | [231.] | 5,4 | (1230.) | 15.4 |
| 88 | Radium | Ra | [226.] | 2 | 700. | 5.0 |
| 86 | Radon | Rn | [222.] | 0 | (−71.) | .009960 |
| 75 | Rhenium | Re | 186.2 | −1,4,7 | 3180. | 21.04 |
| 45 | Rhodium | Rh | 102.905 | 3,4 | 1966. | 12.44 |
| 37 | Rubidium | Rb | 85.47 | 1 | 38.9 | 1.53 |
| 44 | Ruthenium | Ru | 101.07 | 3,4,6,8 | 2500. | 12.2 |
| 62 | Samarium | Sm | 150.35 | 3 | 1072. | 7.49 |
| 21 | Scandium | Sc | 44.956 | 3 | 1539. | 2.99 |
| 34 | Selenium | Se | 78.96 | −2,4,6 | 217. | 4.79 |
| 14 | Silicon | Si | 28.086 | 4 | 1410. | 2.33 |
| 47 | Silver | Ag | 107.870 | 1 | 960.8 | 10.49 |
| 11 | Sodium | Na | 22.9898 | 1 | 97.82 | 0.9712 |
| 38 | Strontium | Sr | 87.62 | 2 | 768. | 2.60 |
| 16 | Sulfur | S | 32.064 | ±2,4,6 | 119. | 2.07 |
| 73 | Tantalum | Ta | 180.948 | 5 | 2996. | 16.6 |
| 43 | Technetium | Tc | [99.] | 7 | (2130.) | 11.46 |
| 52 | Tellurium | Te | 127.60 | −2,4,6 | 449.5 | 6.24 |
| 65 | Terbium | Tb | 158.924 | 3 | 1356. | 8.25 |
| 81 | Thallium | Tl | 204.37 | 1,3 | 303. | 11.85 |
| 90 | Thorium | Th | 232.038 | 4 | 1750. | 11.66 |
| 69 | Thulium | Tm | 168.934 | 3 | 1545. | 9.31 |
| 50 | Tin | Sn | 118.69 | 2,4 | 231.912 | 7.2984 |
| 22 | Titanium | Ti | 47.90 | 3,4 | 1668. | 4.5[illegible] |
| 74 | Tungsten | W | 183.85 | 6 | 3410. | 19.[illegible] |
| 92 | Uranium | U | 238.03 | 3,4,5,6 | 1132.3 | 19.0[illegible] |
| 23 | Vanadium | V | 50.942 | 2,4,5 | 1900. | 6.1 |
| 54 | Xenon | Xe | 131.30 | 0 | −111.9 | .005895 |
| 70 | Ytterbium | Yb | 173.04 | 2,3 | 824. | 6.959 |
| 39 | Yttrium | Y | 88.905 | 3 | 1509. | 4.472 |
| 30 | Zinc | Zn | 65.37 | 2 | 419.5 | 7.133 |
| 40 | Zirconium | Zr | 91.22 | 4 | 1852. | 6.489 |

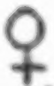
For discussion purposes only

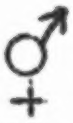
Grade Ten

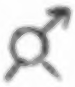
## BIOLOGICAL SYMBOLS COMMONLY USED

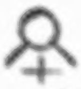
DIAGRAMMATIC SYMBOLS:

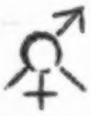

Male

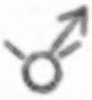

Female

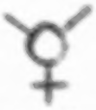

Hermaphrodite

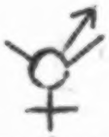

Male
Animal

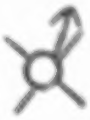

Female
Animal

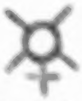

Hermaphrodite
Animal

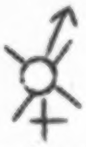

Male
Plant


Female
Plant


Hermaphrodite
Plant


Male Plant
or
Animal


Female
Plant or
Animal


Hermaphrodite
Plant or
Animal

DIAGRAMMATIC SYMBOLS:

Δ energy

~ high energy bond

Ⓟ phosphate group

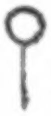
Biology Symbols Commonly Used - Continued

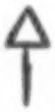
DIAGRAMMATIC SYMBOLS:

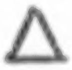
Organic

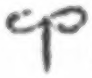
| | | | |
|---|---|---|---|
| A | Adenine   T   Thymine | G | Guanine   C   Cytosine |
| ADP | Adenosine diphosphate | ATP | Adenosine triphosphate |
| DNA | Deoxyribose nucleic acid | RNA | Ribose nucleic acid |
| $TPN\text{-}H_2$ | Triphosphopyridine nucleotide | PGAL | Phosphoglyceraldehyde |
| ACTH | Adrenocorticotropic hormone | $[CH_2O]$ | Carbohydrate |
| RuDP | Ribulose diphosphate | | |

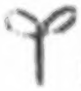
Ecology

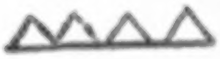

canopy

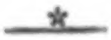

sub canopy

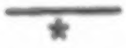

herbs

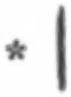

forbs

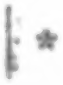

grasses


floor (ground) covering


Northern hemisphere


Southern hemisphere


New world


Old world

Reproduction

| | | | |
|---|---|---|---|
| ○ | individual, especially female | □ | individual, especially male |
| T | dominant | tt or TT | homozygous |
| t | recessive | Tt or tT | heterozygous |
| n | monoploid | 2n | diploid   3n   triploid |
| X | crossed with | P | parent   F   filial generation |

For discussion purposes only Grade Ten

INSTITUTES FOR SCIENCE TEACHERS
TWIN CITY CENTER
SOUTHWEST HIGH SCHOOL DEC. 1 & 2, 1961

HOW I DO IT SESSION

## OSMOSIS IN A NON-LIVING SYSTEM

Purpose: To study osmosis in a closed membrane, non-living system.

The beauty of this experiment as compared to many osmosis experiments or demonstrations is that it can be conducted in a relatively short time. A period of one hour works well but the results are more spectacular if it can be done over a two hour time span. It does not have to set in a window for a day or two before results can be observed.

Directions: Work in pairs or in groups and conduct the experiment as follows:

1. Line up five tumblers and number them 1 - 5.
2. Cut five 20-cm lengths of cellulose tubing from the rolls which have soaked in a pan of water for at least 15 minutes.
3. Cut ten pieces of string, each about 20-cm long.
4. Tie one end of each of the five pieces of tubing by folding the end back about 3-cm and tying it tightly with one of the pieces of string.
5. Gently press the easily removed water out of the bag, then fill the bag with distilled water. (25 ml.)
6. Carefully remove the air at the top by gently squeezing the lower part of the bag. Then fold the open end of the bag over so the air is excluded but little or no water is lost, and tie it tightly with a string.
7. Cut off the excess of the strings with which the ends of the bag are tied, and also the excess overlap of the ends.
8. Rinse the bag, then gently blot it with paper towelling.
9. Weigh the bag on a triple beam balance to the nearest 0.5 gram. Record the weight on the data sheet provided.
10. Place the bag in tumbler #1.
11. Use the same technique in preparing bags 2 - 5, filling them as follows:
    Bag 1 - 25 ml of distilled water.
    Bag 2 - 25 ml of 0.4 M sucrose solution 136.5 g - qs to 1 L.*
    Bag 3 - 25 ml of 0.8 M sucrose solution 273 g - qs to 1 L.
    Bag 4 - 25 ml of 1.2 M sucrose solution 410 g - qs to 1 L.
    Bag 5 - 25 ml of distilled water.
    *(A 0.4 molar solution (0.4M) contains 4/10 of a gram molecular weight of solute (in this case sucrose) in a liter of solution.)

## OSMOSIS IN A NON-LIVING SYSTEM (continued)

12. Be sure to rinse each bag and blot before weighing it, so as to remove any sucrose which has gotten on the outside.
13. When the bags are in the correspondingly numbered tumblers, fill tumblers 1 - 4 with distilled water, and tumbler 5 with 1.2 M sucrose solution.
14. At the end of 15, 30, 45, 60, and 75 min. periods (or whatever even time intervals you select), remove the bags from the tumblers, blot them with paper towelling, weigh them separately, and record the weights on the accompanying data sheet.
15. Plot on graph paper the changes in weight of each bag with time. Change in weight is plotted on the vertical axis (ordinate), and time on the horizontal (abscissa). Label the graph completely.

FROM: Biology, 1959 New Hampshire State Department of Education Concordance

PLASMOLYSIS:

Observe a live Elodea leaf under a microscope. Focus on a barb cell with high power. Note the location and behavior of chloroplasts. Attempt to locate the cell membrane. It will play a major role in the experiment.

Introduce a 5% salt solution by placing two drops of solution on one side of cover glass. Draw the solution under a cover glass by introducing paper toweling to the other side of the cover glass. Observe the behavior of the cell membrane and cell contents after three to five minutes. Water has passed outward through the cell membrane forcing the cell contents and membrane to gather in the center of the cell.

Flush the salt solution from the slide by reversing the previous process. Introduce pure water and drain off salt solution with paper toweling. Watch for indications of the cell contents returning to normal.

0.14 M NaCl will give a light reaction. 0.2 M NaCl will produce a very noticeable reaction, and 1.0 M NaCl will produce a dramatic reaction.

FROM: Biology, 1959, New Hampshire State Department of Education Concordance

DIGESTION:

The effect of gastric juice and saliva on food:

Have various reports made on the work of Dr. Beaumont. Also, use two test tubes and fill one 1/3 full with water and the other 1/3 full saliva. Put food in both containers and watch results.

Digested foods reaching body cells:

Digested foods diffuse through villi membrane to allow the circulatory system to take the food nutrients to the various parts of the body. Demonstrate diffusion through a length of cellulose tubing (sausage casing) filled with a variety of nutrients. Place in water. Later, test surrounding water for the presence of each of the nutrients. Excess sugar is stored in liver until needed. Excess carbohydrates not needed may be converted into fat and stored in fat tissue cells. Proteins are not stored in the body.

1. Digestion of starch: Place 1 cc of saliva in each of five test tubes. Number the tubes, and to tubes Nos. 1-4 add about 6 cc of 1 per cent starch paste. To No. 5 add 6 cc of distilled water. Note the time. Test tube No. 1 immediately for starch by adding iodine. Test tube No. 2 for sugar immediately by adding Fehling's or Benedict's and heat.

   After thirty minutes, test tube No. 3 for starch by adding iodine. Test tube No. 4 for sugar by adding Fehling's or Benedict's. Heat nearly to a boil. Test tube No. 5 (control) by adding Fehling's or Benedict's. This will indicate whether the saliva or water had effect upon the indicator. It is advisable to first test the indicators on stock solutions of sugar and starch to get an accurate picture of the desired color change and concentration.

2. Digestion of protein: Soak some fibrin in distilled water, cut in small pieces, and place one piece in each of four test tubes. Number the tubes. In tube No. 1 add 20 cc of distilled water. Place 20 cc of 0.1 per cent solution of pepsin in No. 2. In tube No. 3 add 20 cc of 0.2 per cent hydrochloric acid. Add 20 cc of 0.1 per cent solution of pepsin in a 0.2 solution of CHl. Shake the contents of each tube and incubate at 37°C. (body temperature). Observe the changes in the protein over the next four hours. Note in which tube digestion does occur.

3. Digestion of fat: Put 5 cc of liquid fat (corn oil) in each of two test tubes and number. Ad 10 cc of artificially prepared pancreatic juice to each tube. Test for pH. Heat tube No. 1 at 37°C. for two hours. Leave other tube unheated for same length of time. Note the emulsion and change in appearance in tube No. 1.

# ANIMAL BEHAVIOR

I. Reactions of protozoa (protists)

A. Response to chemicals:

1. Place a drop of paramecium culture on a slide, do not use a cover slip. Drop a salt crystal in the center of the culture. Record by means of arrows the response of the animal. Observations must be made with a microscope using low power.

2. Repeat as in #1 using a different chemical such as sodium bicarbonate, or other chemicals.

3. Repeat the above using other organisms such as Euglena.

4. Have the student look for evidence of different responses that the protists make to different chemicals.

B. Response to mechanical stimuli:

1. Place a drop of paramecium culture on a slide and add some fibers of cotton. What is the behavior of the paramecium when it comes into contact with the cotton?

2. Repeat using Euglena.

C. Response to light:

1. Place a drop of paramecium culture into a section of capillary tubing. Observe distribution of the animals. Place the tube so that the light strikes it uniformly. Count the organisms to determine distribution.

2. Cover 1/2 of the tube with black paper and place near a window receiving indirect light. After 30 minutes remove paper. Count the paramecia to determine reaction to light.

3. Repeat the above using Euglena.

4. What conclusions can be made about the reaction of paramecia and Euglena toward light?

D. Response to other stimuli: Various other stimuli such as electrical, heat and cold can be used. Other organisms can be used also.

## ANIMAL BEHAVIOR (continued)

II. Reactions of earthworms:

A. Does it learn from experience? Place a "T" shaped apparatus made of pieces of glass. Place the worm in the bottom of the "T" and have it respond to these variations.

1. To electric shock. Set up the apparatus so that the worm will get a shock when it turns into one side of the "T". Does it learn to go into the side without the shocking?

2. Place food or chemicals in one side of the "T" and observe the reaction of the worm to these substances.

B. Response to other stimuli:

1. What response does the earthworm make to sounds? Use whistle, bell and other sounds.

2. What response does it make to light? Use white light, colored light, brightness.

3. What response does it make to smells? Use perfumes, acids, cabbage leaves, meat, onion and other items. Place on cotton and put cotten close to worm.

III. Response of other invertebrates:

A. Grasshoppers, crayfish or other available invertebrates may be used for this with food, light, sounds and other stimuli.

B. Do insects go under barks and twigs because it is dark or because of some other stimulus?

1. Take insects normally under logs, bark and leaves.

2. Allow insect "choice" of going under a piece of cardboard or a piece of glass. Be sure that these are at an angle to allow the insect to touch its back.

3. Check responses to determine whether insect went under the dark one more than under the one that was allowing the light to pass through.

ANIMAL BEHAVIOR (continued)

IV. Response of the male Betta fish:

- A. Allow male fish to be in aquarium for several days. This will give the fish a chance to establish territoriality.
  1. Cut cardboard shaped like Betta. Does fish respond?
  2. Color cardboard red and repeat #1.
  3. Place mirror in water so Betta can see its reflection.
  4. Place another live Betta in water. Care must be used on this one. Be ready to separate fish should response necessitate this action.
- B. Response of Betta is darkening of color, extending gill covers and approaching other fish or object.

V. Response of Robins:

- A. Robins display a territoriality that can be used to study animal behavior.
- B. The male robin responds behaviorally to another male robin in his territory by various responses such as fluffing or smoothing feathers, flicking tail, lowering or raising wing, lowering or raising head and approach or withdrawal in relation to the other bird.
  1. This can be demonstrated by cutting a silhouette of a robin. Color it red and place the cardboard silhouette in the male robin's territory. It will respond behaviorally.
  2. Variations could be to use different colors, different shapes or the sounds of other robins.

## POPULATION GROWTH

I. Use bacteria, yeast cells or some other organism to show population growth. Place a small number of organisms in hay infusion, milk or some other culture media and place in a specific environment such as warm, cool, dark, light, etc.

II. Determine the number of organisms present. There are various ways of counting:

A. Take samples of the culture every few hours. Place the material on a clean dish containing media (inoculate) using sterile technique. Incubate the dish and then count the number of colonies. Prepare a growth graph using this information. This counting technique works well when using bacteria.

B. Take samples of the original culture and place on slide with a cover slip. Take five counts using low power (or high power) to determine how many organisms are present in the low power field. If there are so many organisms that counting becomes difficult a dilution must be done. Then multiply by the dilution factor. Prepare a growth graph from this information. This counting technique works well when using yeast cells.

C. A controlled yeast population growth can be conducted to illustrate the normal growth pattern. Prepare medium (see recipe) and have ten test tubes for each team. Place one dry yeast grain in each of the nine tubes which must be marked to identify them. Do not inoculate the tenth tube because this serves as a control. Count tube #1 one day, tube #2 on day two, etc. This recipe will provide the necessary material for one team. Yeast extract 0.5 g, Potassium phosphate, monobasic 0.4 g, glucose 8.0 g, peptone 1.0 g, and distilled water 200.0 ml. Add the dry volume, dissolve by heating over a low flame, stir constantly. Medium is clear when properly prepared. Place medium in test tubes, cover tubes with aluminum foil and sterilize, allow to cool and then inoculate.

III. Variations of this could include:

A. Incubate the culture at different temperatures or in different environments.

B. Use different media.

C. Use different organisms.

## SEED GERMINATION

Germination time or percentage of germination can be altered in seeds. Some treatments are:

1. Temperature:
   Keep seed at or near freezing for 7 day periods.

2. Water:
   Soak seed in water (periods of 24 hours to one week). Variations could be to alternate the soak (12 hours) with the non-soak (12 hours).

3. Sulfuric acid:
   Soak in concentrated and/or dilute sulfuric acid for five minute intervals. Have time variations from five minutes to one hour.

4. Scarification:
   Notching through the seed coat.

Determine the best results by using control plants. Variations of this would be to check viability of seeds, with or without the treatment. For this mark 100 squares in the growing area. Place one seed in each square and count the number that germinate.

# FERTILIZER EFFECT ON PLANT GROWTH

Commercial fertilizers usually include nitrogen, phosphorus or phosphoric acid and potassium in varying amounts. There are many variations that may be used to this activity.

Place one seed (bean, barley, tomato or other common seed) in the soil of 10 greenhouse pots. Allow growth of about one week after germination begins. Number the pots 1 to 5 so there are five pairs.

1. Control--just add water.
2. Add bone meal (phosphorus). Because it is not water soluble, place two tablespoons in holes made near the roots of the plant. Cover the holes and water. Apply bone meal (available from local greenhouse) every four days.
3. Add two tablespoons of ammonium nitrate by sprinkling over top of soil. Then add water. Apply every four days.
4. Add two tablespoons of muriate of potash using same method as with phosphorus.
5. Add some of each chemical in the following ratio using the same method described above for each chemical: 1 tablespoon ammonium nitrate, 2 tablespoons bone meal, 1 tablespoon potash.

Check and record growth. Total time for the activity will be about four weeks.

## SOIL ORGANISMS

Mark a specific area (1/2 sq. ft. or 1/3 sq. meter) in grassy area. Carefully place the soil from the marked area into a container, observing so that organisms do not escape. The ground should be moist, but not wet and sticky. Variations could be to take soil from different areas such as sandy (dry) areas, beach, just at water level, etc. Most of the animal life will be in the upper part of the soil, so digging approximately five inches deep will be sufficient.

Examine the soil in the lab. Separate the organisms as they are found. Placing them in special containers so they do not escape will facilitate counting.

Students can identify organisms, make identifying keys, show relationships of plants and animals to environment, determine whether organism is a plant or animal, make population counts and other aspects of soil study.

## SIMULATED EPIDEMIC

Divide the class into groups of about five per group and have each group handle a piece of candy that has been dipped in a culture of *Serratia marcescens*. Before the candy or other object is handled by each group, the members should rub their finger tips of the right hand across the surface of a nutrient agar plate. This should be done before washing and after washing. Use a third plate to rub finger tips after handling candy. A variation is to have one member of the group handle the candy and then shake the hand of member No. 2, No. 2 shakes hands with No. 3, etc. until all members of the group have participated. When hand shaking is completed the members will rub the finger tips on agar plate. Incubate plate 24-48 hours and trace how the culture spread.

# FROG PARASITES

Using pithed frogs in the laboratory has several advantages. One is that the students can look for living parasites.

External parasites are likely to be the larvae of a mite. They will be imbedded in skin, especially on the inner side of the thigh were they appear as reddish spots. Remove them with a teasing needle and place in a drop of water on a slide and observe.

In the search for blood parasites puncture the heart of a large blood vessel and place a drop on a slide. Add the coverslip and observe. You may find microfilariae and/or trypanosomes.

In the body cavity search for ascarid larvae encysted in mesentery, adult filariae lying under mesenteries and encysted larval flukes, tapeworms or Acanthocephala in the mesenteries, liver or body wall. Any parasites removed should be placed in a watch glass for observation and noted where they were found.

In the lungs and bronchial tubes look for flukes and nematodes. Examine these on a slide.

Remove small intestines and wash out with saline solution using a syringe. Check solution for flukes, tapeworms or nematodes.

Remove some large intestinal contents nearest the mucosa with a toothpick. Place this in a drop of saline solution on a slide and examine for protozoa, flukes and nematodes.

Also check the urinary bladder for flukes.

This method enables the students to observe the parasites in a natural state. They are more readily identified and observed while movement and coloration are natural.

## SOME HEREDITY EXPERIENCES

I. Ability to taste P.T.C. chemicals:

A. P.T.C. test paper is easy to use and the results can be used to determine ratios, set up family trees and illustrate other genetic principles. Soak filter paper in phenyl-thio-carbimide or buy P.T.C. test paper from a supply house.

B. Have each student chew (do not swallow) paper for one minute. If the student is a "taster" he will react to the harmless but distinct taste. If he is a "non-taster" there will be no reaction.

II. Ability to roll tongue (to place tongue in U-shape longitudinally):

A. In most cases either the individual can longitudinally roll the tongue or the tongue can not be rolled regardless of how much practice is involved.

B. Have the students check their families for this trait and have them apply the principles of genetics to this trait. What is the ratio? Is it dominant or recessive? Etc.?

III. Open or closed ear lobes:

A. Individuals have a lobe that is closed if the lower part of the lobe is attached. It is open if it is not attached. Open is dominant.

B. Have the students check their families for this trait.

IMPROVING INSTRUCTION

For discussion purposes only

Grade 10

# IMPROVING INSTRUCTIONS

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Booklet - AO Reports on Teaching With the Microscope

For discussion purposes only Grade 10

## SUGGESTIONS TO THE TEACHER OF BIOLOGY

## FOR

## GREATER CLASSROOM INSTRUCTIONAL COMPETENCE

This list of suggestions may be used in a number of ways by the biology teacher who wishes to increase his classroom instructional competence. You may wish to review them for developing a plan of self improvement. You may have an observer use them as a sort of a check list in making suggestions for the improvement of your instructional skills. You may wish to use this list to develop a modified list for your own use. The reviewing of this list occasionally will bring to mind other things which you can do to improve your abilities as a teacher of biological science.

### A. Preparing to teach science

1. Secure a copy of the Minneapolis science curriculum guides and study them carefully to discover what contribution you should make as your students learn biology.

2. Study the State of Minnesota Course of Study in Biology. It is available in the Board of Education Library.

3. Study several other school systems courses of study in biology. (Available in the Board of Education Library and Science Department Office.) Examine Resource Units and Teaching Units on Biology at other schools.

4. Examine several science education textbooks used by nearby colleges and universities in their pre-service secondary science methods courses.

5. Analyze your own strengths and weaknesses in biological content as you review the course of study.

6. Set up and begin a plan to remove your own content and instructional deficiencies.

7. Visit as many different classes in biology as possible. Observe some elementary school and junior high school science classes as well as classes of special sciences being taught in the senior high school.

8. Talk with experienced biology teachers, asking them how they solve some of their instructional problems. Make notes on all suggestions received. Attend and participate in the biology in-service sessions each month.

9. Compare your diagrams and symbols with those used in standard textbooks. If you are not using conventional symbols, write correctly the symbols used by the textbook.

A. Preparing to teach science - continued

10. Start collecting, classifying and filing pictures, puzzles, games and exhibits that relate to the units or topics in biology which you should teach.

11. Pre-plan each semester's work so that a balance of time allotments is made for each unit.

12. Subscribe and regularly read at least two professional journals, such as: The Science Teacher, School Science and Mathematics, Biology Teacher, Bioscience, Journal of Chemical Education, Science, Chemistry, Physics.

13. Read or review the following yearbooks: National Society for the Study of Education.

    a. Vol. 3, Part I
    b. Vol. 46, Part I
    c. Vol. 59, Part I

## B. Preparing to Chart a Straight Course

1. Read the preface and/or the Introduction in the textbook which the students will use. Determine the author's viewpoint.

2. Familiarize yourself with the teacher's manual for the textbook.

3. The textbook is only one source of information. Avail yourself of others, including those found in your school's library and on the Biology Supplement's Bibliography listing.

4. Remind yourself that it is not your purpose to make biologists of all your students.

5. Do not limit the biology which you teach to only the immediate demands of the average person.

6. Keep in mind that the distinct purpose of biology instruction in the senior high school is to provide orientation and understanding of the world of living things.

7. Determine a purpose for each lesson and bend every effort to achieve the objectives of each lesson.

8. Let the students know at the beginning of each lesson what are your objectives.

9. Teach biology to your pupils; don't just present biology.

10. Point out for some of your pupils the "bread-and-butter" values of the biological sciences.

11. Think through and be prepared to give your pupils the answer to the question, "Why study biology?"

12. Crystallize in your own mind what you believe about the "transfer of learning as it is related to biology."

## C. Motivate students in science

1. Prepare students to be receptive to each new concept before it is taught.
2. Appriase the total classroom atmosphere and build a good esprit de corps.
3. Inventory a student's scientific abilities and skills. He cannot learn something which he already knows.
4. Take advantage of the wonder motive and the systematizing motive in the learning of biology.
5. Preview the next lesson for your class as you make the pupil assignments.
6. Summarize the lesson for your class at the end of the class period before the bell rings.
7. Lecture sparingly.
8. Demonstrate copiously.
9. Place things in the pupils hands to learn with.
10. Emphasize the multitude of problems suggested by a field trip.
11. Use positive motivation rather than such negative devices as grades, fear, punishment, and/or sarcasm.
12. Encourage the enjoyment and thrill of reading about and seeing living things and their development.
13. Refer the students as to the daily newspaper and current magazines for the challenging problems facing us today in biology.
14. Provide opportunity for science prone students to demonstrate before the biology class their original experiments in solving some problem or answering a current question in biology.
15. Encourage your students to face and attempt to work at solving unsolved biological problems.
16. Help them to cultivate perseverance in their problem solving technique. Beware! -- Do not give assistance too soon or too late.
17. Do not remove the thrill of discovering by telling.
18. Prove to your students that you want them to grow in scientific understandings, the use of scientific tools and the solution of scientific problems.
19. Move toward more **LABOR**atory teaching of biology.
20. Stimulate interest in biology by assigning displays or pictorial reports of famous biologists and their contributions.

## D. Use materials and resources

1. Use a variety of sensory aids and resources: film, filmstrip, recordings, television, experiments, flannel boards, bulletin boards, transparencies, living plants and animals.
2. Construct with your students' aid and suggestions a kit of materials which has been found to be effective in teaching each unit.
3. Equip your classroom as a LABORatory for teaching biology; include visual materials, symbolic forms and exploratory tools.
4. Make the chalkboard a part of student demonstrations and explanations.
5. Chalk as you talk!
6. Use developmental drawings and/or overlays on the overhead projector.

## E. Teach the lesson

1. Treat the textbook kindly. It is your best friend, but not your master.
2. Teach so as to achieve pupil participation and discovery.
3. Locate evidence for an answer. Don't vote or accept majority opinion on question's answers.
4. Change your teaching pace and techniques frequently.
5. Monotony thrives on abstractions.
6. Require of your pupils an understanding of the basic principles, instead of just a correct answer.
7. Require scientific effort from all pupils-gifted, average, and slow.
8. Leave the "I want" out of your assignments.
9. Leave the "I believes" out of your discussions.
10. Set high standards of neatness in all written assignments to be handed in. Experimental data and reports should not be rewritten because something is usually lost.
11. Involve students in the core of biology learning experiences.
12. Require the correct reading of all scientific symbols--i.e. $O_2$= molecular oxygen.
13. Harmonize orderly and systematic class procedures with the orderliness and exactness of biological science.
14. Realize that teaching pure biology to youth may be "too rich" for consumption for some of them.
15. Think in terms of informational biology as well as biological evidence.
16. Find a basis in a previous experience of the student that will involve the principle of biology to be presented.
17. Be cautious concerning student verbalizations. They may not know as much as you think they do!
18. Emphasize the development of the ability to grasp ideas; methods and principles in the finding of biological evidence, rather than just skill in the manipulation of tools.
19. Help the students to develop methods of attack on problems and the ability to make use of the processes of inquiry.

E. Teach the lesson - continued

20. Guide students in successful procedures for attacking thought problems involving experimentation.

21. Spend precious class time building meanings into cause and effort relationships.

22. Collect and record grades and other routine clerical details before or after class and during your preparation period.

23. Supervise your students during a class study period in order to give them individual help.

24. Administer frequent short quizzes to keep contact with the students' understandings.

25. Test--teach--retest--reteach.

26. Consider as possible causes of pupil failure: physical defects, poor motivational attitudes, poor experience backgrounds, lack of feedback from the learner, and a lack of understanding of the basic concepts.

27. Diagnose pupil difficulties by means of prepared homework, class responses and diagnostic tests.

28. Become familiar with the Minneapolis school-wide testing program which has been participated in by your pupils.

29. From the accumulative record card chart and/or graph pertinent test data about their ability and achievements.

30. Help pupils to develop an ability to recognize reasonable results and outcomes.

31. Admit your own scientific errors and work toward eliminating them.

32. Build understandings before you require drill.

33. Vary the types of drill used in teaching biology for understandings--not facts.

34. Vary the doses, time, content and participants in drills.

35. Introduce novelty in your drill by the use of devices such as electric answer boards, puzzles, games.

36. Be familiar with and use at different times all the different types of lessons in biology: inductive development, deductive development, drill review, examination, appreciation, and discussion.

37. Try the review lesson which summarizes the main features of the work but in a means different from that which you have used previously.

## F. Making Assignments and Homework

1. Assist pupils with their assignments by systematic procedures and individual help.
2. Know the school's policy regarding homework.
3. Do not use homework assignments as punishment.
4. Follow up class correction of homework with a discussion of errors and their causes.
5. Assume that the students will learn their biology in class. Homework should provide reinforcement for learning.
6. Practice differentiation in making assignments.
7. The outside assignments to be prepared before coming to class must do something for the pupil--not for the instructor's benefit.

## G. Meeting individual differences

1. Try at least three levels of work in your class:
    - a. an enriched program for accelerated pupils.
    - b. a core program for the average or normal pupils
    - c. a minimum program for the slow-learning pupils.
2. Determine the level at which each student should work and does work.
3. Since good teaching separates individuals, provide for individual differences in your teaching.
4. Practice pupil grouping within each class.
5. Accept each pupil on the level at which he can perform.
6. Remember that you teach and that they learn--in their own way and at their own rate.

JHS/lvl
3/10/66

AO REPORTS ON TEACHING WITH THE MICROSCOPE to be inserted here.

American Optical Company
Instrument Division
Buffalo 15, New York